Detailed Project Report

And Environmental Assessment

Small Beach Erosion Control Project

Belfast City Park Beach
Belfast, Maine

MAY 1985

US Army Corps of Engineers
New England Division

SYLLABUS

This report on Small Beach Erosion Control Report was prepared by the Corps of Engineers at the request of the city of Belfast, Maine. Work was accomplished under the authority of Section 103 of the 1962 River and Harbor Act as amended. The magnitude and causes of the erosion problem were assessed. It was determined that wind and storm generated tidal surge do indeed cause severe damage to the beach. Losses take the form of flood damage to the backshore area and lost recreational opportunity. This report goes on to describe, evaluate and recommend certain corrective measures.

Belfast City Park Beach is located midway along the southwest side of Belfast Bay. The beach is 780 feet long and fronts a 28.5 acre park owned by the city of Belfast. It is the only public beach in the area that provides recreational sunbathing and swimming opportunities. The park also includes a saltwater swimming pool, bathhouse, picnic area and parking area.

In November 1980, the city requested that the Corps undertake a study because of the steady deterioration of the beach and impending damage to the backshore. The reconnaissance report was completed in October 1981 and recommended a Detailed Project study which was undertaken in October 1982.

This Detailed Project Report presents and evaluates several alternative plans for erosion control at Belfast City Park Beach. The most efficient plan includes:

> Beach widening by the placement of suitable sandfill along 550 feet of Belfast City Park Beach up to a backshore elevation of 15.0 above mean low water, (10.4 feet above the National Geodetic Vertical Datum) and the construction of two terminal groins located at the northern and southern limits of the beach. The plan also includes 20 feet of rock revetment north of the northern groin structure and another 20 feet of rock revetment south of the southern groin structure.

This selected plan will provide a 50 foot wide level beach berm with a usable dry beach space width above the mean high waterline of approximately 112 feet, over the entire 550 foot long beach.

The Division Engineer recommends that, subject to certain conditions of non-Federal cooperation, the selected plan as recommended in this report be authorized as a beach erosion control project under Section 103 of the River and Harbor Act of 1962, as amended. The estimated first cost of construction for this project is $363,000 and is to be borne by the United States and the city of Belfast. The Federal share is estimated at 70 percent or $254,100, and the non-Federal share is estimated at 30 percent or $108,900. The beach will also require periodic nourishment, estimated to cost $9,900 annually. Nourishment will be shared in the same proportion as the first cost of construction. Total annual charges are $40,900 and the annual project benefits are $200,000 providing for a benefit-cost ratio of 4.9 to 1. All aspects of this report are subject to the approval of the Chief of Engineers.

BELFAST CITY PARK BEACH
BELFAST, MAINE
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DETAILED PROJECT REPORT

This detailed project report analyzed beach erosion problems and recreational needs that currently exist at Belfast City Park Beach. Belfast City Park Beach is located on Belfast Bay, at the northwestern end of Penobscot Bay, roughly midway along the Maine coast and is approximately 780 feet long. The 28.5 acre park, which lies behind the beach is a popular recreational area with backshore facilities such as swimming pool, ball park, lighted tennis courts, playground, picnic area, basketball court, etc. This report contains detailed engineering, environmental, and economic analysis that identifies the beach erosion problems at the area.

STUDY AUTHORITY

This report was accomplished under the authority granted in Section 103 of The River and Harbor Act of 1962, as amended which provides authority for the Chief of Engineers to construct small shore and beach restoration and protection projects. A project will be adopted for construction under Section 103 only after a detailed investigation and study clearly shows the engineering feasibility and economic justification of the project. Each project must be complete, and limited to a Federal cost of not more than $1,000,000. This Federal cost limitation includes all project related costs for the report preparation, design, construction, investigations, supervision, and administration. The project as developed under Section 103 is formulated to provide the same complete-within-itself project that would be recommended under regular authorization procedures. No additional work should be required to assure effective and successful operation of the project. Under this program a dependent increment or portion of a larger overall project is not eligible for construction.

SCOPE OF STUDY AND PURPOSE

This study evaluated approximately 780 feet of existing beach at City Park and to maintain the quality of the existing backshore park to provide much needed public beach area. The damages that storm winds and waves cause to the shoreline were investigated along with alternative plans of improvement for providing shore protection, encouraging healthful recreational beach bathing, and preventing future damages to the embankment and backshore park. This detailed analysis was conducted using all the elements necessary to insure that a successful economic water resource plan would be developed for the study area. Detailed studies of the social and environmental features of the area and associated construction costs for the considered plans, and other related matters were also included.

PRIOR STUDIES, REPORTS, AND EXISTING WATER PROJECTS

In October 1981, the Corps completed a reconnaissance report of City Park Beach. This action was in response to the request of 20 November 1980 from the City of Belfast. This report was completed in accordance with the authority of Section 103 of The River and Harbor Act of 1962 as amended for Small Beach Erosion Control Projects. The reconnaissance report recommended that a full-scope beach erosion control study be undertaken. There were no detailed project reports completed prior to this report for Belfast City Park Beach or on other beaches in the immediate area.

EXISTING CONDITIONS

Belfast City Park is located midway along the southwest side of Belfast Bay, approximately 30 miles south of Bangor. The park is a very popular city-owned recreational area and is the only public facility in the city of Belfast. The park area extends approximately 1,100 feet behind the rocky shorefront and consists of approximately 28.5 acres of developed recreational area. The beach which is rocky and extends along the 780 feet of shorefront is on the ocean side of the park. At present there is little dry beach space available at mean high water. The foreshore area consists of a fine-to-coarse grade of sand, is relatively flat and is strewn with medium-size rocks. The backshore area is protected by an embankment which is between eight and fifteen feet high. At mean highwater the base of the embankment is currently being undermined. There is evidence of very severe erosion during frequent winter storm conditions. The backshore park area is bound on the north and the south by private property. The park facilities include parking areas, a swimming pool, a ballfield, playground equipment (swings, etc.), picnic areas, a bathhouse and restroom facilities.

PROBLEMS, NEEDS, AND OPPORTUNITIES

The problem is one of severe erosion of the backshore embankment area and the lack of adequate recreational beach space above mean highwater. This progressive erosion is resulting in the loss of valuable recreational area and will soon be threatening the park's facilities. There exists at Belfast City Park the need for a dry beach bathing area and the opportunity to enhance the quality of the beach and to protect the existing park. There is little evidence of a natural supply of beach materials that exist along the adjacent shores so the rate of return for any natural seasonal nourishment at the beach is very low. The present rate of erosion at the beach averages approximately 1.0 foot per year.

NATIONAL OBJECTIVES

The process of evaluating plans was carried out by establishing the contribution of each alternative, to the problem and opportunity statements for beach erosion control projects. The national objective investigated and given prime importance in the planning process was the National Economic Development (NED). Each plan was evaluated in accordance with this National Objective as it applies to the water resource planning requirements. The plan which resulted in the maximum net economic return was designated the NED plan. Careful consideration was also given to the Environmental Quality (EQ), the Regional Economic Development (RED), and the other Social Effects (OSE) accounts. Desirability of the plans will depend on the beneficial and adverse impacts to the planning objectives for the study area.

The main objective is discussed below:

National Economic Development increases the nations output of goods and services and improves its economic efficiency. This is accomplished by:

- Prevention of loss of land and other physical damages
- Reduction in maintenance costs
- Increased recreational usage
- Employment benefits

Minor consideration was given to the following objectives:

Environmental Quality is to enhance the environment through management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural, cultural, and ecological resources.

Regional Economic Development is concerned with a project's effect on the region. The following criteria were considered:

- Effects on employment, income and economic base
- Effects on regional recreational activities
- Effects on local commercial and industrial activities
- Effects on public services and facilities

Other Social Effects considers the direct and indirect implications that will rise from the proposed project on the population and their lifestyle. Consideration was given to the following:

- Community disruption
- Effects on health, safety, and community well-being
- Effects on desired community growth
- Effects on educational, cultural, and recreational opportunities
- Effects on emergency preparedness
- Effects of noise during construction that would tend to raise the overall noise level of the area over the construction period.

CONDITION IF NO FEDERAL ACTION IS TAKEN

Belfast City Park Beach will continue to erode and undermine the backshore park and pavilion if the Federal Government does not undertake a beach restoration program. The city of Belfast has indicated they will be unable to maintain the beach without involvement from the Federal Government. Therefore, a restoration program for the beach will provide protection to the backshore park as well as increase the beach width to alleviate the overtopping of the beach, and provide the much needed beach space.

PROBLEM AND OPPORTUNITY STATEMENTS

Problem and opportunity statements are derived from known areas of public concern and from anticipated "without project" conditions that are likely to occur. The statements define water and land related resource management needs that can enhance the National Economic Development (NED) account. Based on these items, the following problem and opportunity statements were established:

- Contribute to the safety and comfort of the users of the beach.
- Contribute to the economic strength and well-being of the area.
- Preserve the environmental quality of the area.
- Contribute to the continued recreational use of the beach.
- Contribute to the stability of the beach.
- Preserve the backshore park.

PLANNING CONSTRAINTS

Consideration was given to many concerns during the process of developing the considered plans of improvement, but only a few of these concerns will be identified as constraints.

Planning constraints are limitations that are taken into consideration in the planning process. These limitations are based on a wide range of concerns, such as natural conditions, social and environmental factors, economic limits, and legal restrictions.

The following constraints were found to be relevant to the study:

o Avoid adverse effects on the local soft clam population.

o Avoid adverse effects on adjacent shore configurations. Any work performed on this beach must not cause deterioration to any adjacent beaches, waterways and inlets.

o The city's financial capabilities are limited; therefore, the plans that are formulated should not put unreasonable financial burdens on the city of Belfast.

FORMULATION OF PRELIMINARY PLANS

Consideration was given to both structural and nonstructural solutions in formulating alternative plans for Belfast City Park Beach. All of the alternative plans developed and addressed a broad range of publicly-held concerns. The economic, environmental, and social needs were taken into consideration in formulating the plans. Meetings were held with Federal, State and local officials to determine their preferences and desires in arriving at the selected plan of improvement. Each plan is screened for feasibility and justification during the study and depending on the conclusion, is either recommended for further detailed analysis or eliminated from the study.

ALTERNATIVE PLANS

As a basis for formulating alternative plans, a broad range of structural and nonstructural plans were examined as possible solutions to the problems at Belfast City Park.

Nonstructural measures included;

- Do nothing approach, thereby allowing the beach and backshore to continue to erode naturally.
- Improve the backshore and existing recreational facilities.
- Limit the number of beach bathers on peak days.

Structural measures included:

- Place suitable sandfill along the entire beach area.
- Construct groin structures to compartmentalize the beach.
- Construct an offshore breakwater.
- Place rock revetment along the backshore.

DESCRIPTION OF PLANS

The structural and nonstructural plans mentioned earlier were studied for their applicability in correcting the problem of the eroding shoreline and insufficient beach space for the public use. The non-structural plans were considered in the planning process but were not feasible because the plans do not meet the problem and opportunity statements and the national objectives.

The existing beach length is approximately 780 feet long. The sandfill plans considered a length of 550 feet. This length was chosen so that the project will not impact the clamming habitat at the northern and southern extremities of the beach. The 550 foot beach length would not impact the adjacent private properties as would the 780 foot length. This was coordinated with Federal and State agencies along with the city of Belfast.

The Sandfill Plans (1 through 4) listed below all consider 50, 75, or 100 foot berms, a beach length of 550 feet, and have a backshore elevation of 15.0 feet above mean low water (10.4 feet NGVD). Plans 2 through 4 will also have 20 feet of rock revetment north of the northern groin structure and 20 feet south of the southern groin structures (wherever a structure is placed) to prevent scouring and erosion of the adjacent embankment. The top elevations of the groin structures and rock revetment is 16.0 ft mlw (11.4 ft. NGVD).

Plan 1 - sandfill only along the beach.
Plan 2 - sandfill and construction of two terminal groin structures at the northern and southern limits of the beach.
Plan 3 - sandfill and construction of a terminal groin structure at the northern limit of the beach
Plan 4 - sandfill and construction of a terminal groin structure at the southern limit of the beach.
Plan 5 - rock revetment along the 780 foot backshore area.
Plan 6 - construction of an offshore breakwater approximately 1000 feet in front of the 780 foot beach.

COMPARATIVE ASSESSMENT AND EVALUATION OF PLANS

Contributing to continued recreational beach use and the stability of the beach was among the concerns of Federal, State, regional and local interests. Plans 1 through 4 would stabilize the beach, provide continued recreational use of the beach, and protect the backshore park. Plan 5, rock revetment and Plan 6, offshore breakwater would only provide protection to the backshore park from storm driven waves. The revetment would only protect the backshore park and not contribute to the recreational use of the beach. The offshore breakwater would only reduce the rate of erosion and would not stabilize the beach. These two plans do not contribute to the recreation of the beach.

Plans 5 and 6 are costly and the minor benefits that they provide would not justify for the high cost of construction. These plans are also more environmentally damaging than the sandfill plans and by not halting the erosion would not enhance the environment. These plans do not meet the criteria in the problem and opportunity statements or the National Objectives and will not be considered further. Plans 1 through 4 are viable alternatives that were formulated to contribute to the study objectives of the area. These plans will be compared and a trade-off analysis will be performed in the "Assessment and Evaluation of Detailed Plans" section to determine which option best meets the needs and desires of the area.

Plans 1 through 4 meet the criteria that were set forth in the problem and opportunities statements. These plans have been selected for further evaluation since they satisfy the requests of the Federal, State, regional, and local interests groups for reducing the loss of valuable beach and improving the quality of the beach to meet the future and present demand for recreational needs of the area.

ASSESSMENT AND EVALUATION OF DETAILED PLANS

This section contains an analysis of Plans 1 through 4 which are selected for further detailed study. Evaluation of these options are based on their attainment of the project problem and opportunity statements.

The detailed plans of improvement considered for this final evaluation were developed using the preliminary design data recommended in the reconnaissance stage planning report, and input received from the concerned public. These two factors were first and foremost in developing the plans which would support improved recreational use and efficient shore protection, based on the needs and desires of the city of Belfast. The various improvement methods considered are groin(s) and sandfill. Each method has a distinct function, and either or a combination of the two that is most efficient, environmentally, and economically acceptable will be selected. The proposed sandfill would prevent overtopping of the beach and provide protection to the eroding backshore and also provide additional beach area. Groin(s) would provide an effective sand retention measure.

Plans 2 through 4 utilize various placements of two structures; terminal groins at the northern and southern limits of the beach. The net movement of alongshore material moves in a northerly to southerly and southerly to northerly direction with the net movement to the north. Since this littoral movement is to the north, Plans 1 and 4 would only apply a temporary solution to the problem and the sandfill would not stay on the beach for very long. The two plans would have a higher nourishment rate and could impact the adjacent shorelines and the offshore clamming areas. Therefore Plan 2, with two terminal groin structures and Plan 3 with one terminal structure are more acceptable, since their nourishment rates are lower than Plans 1 and 4, resulting in lower costs. From this analysis, Plan 2 and Plan 3 will be carried further for a more detailed analysis. (See Appendix 3 for a further detailed analysis.)

DESIGN CRITERIA

The proposed plans of improvement were designed to provide needed protection against wave action experienced during frequent winter storms generating waves from the northerly to southeasterly direction and to provide and preserve a much needed recreational beach bathing facility. The improvements would also provide substantial erosion control protection from frequent severe storms. Pertinent design features are described below. (See Appendix 3 for details.)

DESIGN TIDE

The design tide selected is 14.0 feet above mean low water (9.4 feet NGVD) and is expected to occur with a frequency of about once in twelve years. The design tide elevation was selected as the maximum practical level that should be considered in constructing protection for the generally low-backshore area. (See Appendix 3 for details.)

DESIGN WAVE

The design wave height for the proposed improvement was determined in accordance with methods developed by the Office of the Chief of Engineers (OCE) and the Waterways Experiment Station (WES). The computed shallow water wave heights are the maximum heights that can be attained, based on the fetch, depth and duration. These heights were analytically reduced to allow for the effects of shoaling. The design wave is the maximum wave height that could occur at the beach using Engineering Technical Letter (ETL) 1110-2-305. The influence on the wave was due to refraction and defraction and was found to be the governing factors. The design wave at the beach is a 5.0-foot breaking wave, with a 3.7-second period. (See Appendix 3 for details.)

WAVE RUN-UP

Wave run-up on the proposed structures and sandfill was compiled for a storm estimated to occur with a frequency of once in twelve years. An allowance was made for some erosion of the beach in selecting the wave height based upon past coastal engineering experience and conditions observed after storms. A 5.0-foot, 3.7-second wave would cause a wave run-up to an elevation of about 1.60 feet above the design stillwater elevation (14.0 ft. MLW or 9.4 ft. NGVD) or to 0.60 feet above the proposed beach berm elevation, (15.0 ft MLW or 10.4 ft. NGVD) based on an average beach slope of 1 vertical on 15 horizontal.

SANDFILL AND PERIODIC NOURISHMENT

The proposed project will require a substantial amount of sandfill to provide protection to the backshore to meet the recreational needs of the beach. The sandfill required will be clean and free of pollutants. A preliminary study of offshore sandfill sources from nearby Belfast Bay shows that the existing sandfill consists of very fine material and does not meet the design criteria specified in the 1977 Shore Protection Manual. Dredging of the bay could seriously impact the soft shell clam areas. A commercial sand source meeting the specified criteria located in the vicinity of Belfast would be used. Our investigation of the source of beachfill material indicates that sufficient material is available from local commercial sources that would satisfy our specified criteria. More detailed information on sandfill criteria is shown in Appendix 3.

Annual periodic sand nourishment for the project is included as part of the construction cost. This sand nourishment is necessary to maintain project dimensions and is based on available historic data of losses that have occurred in the area.

GROIN DESIGN

The terminal groin structure(s) was designed based on a stillwater elevation of 14.0 feet above mean low water and a 5.0 foot breaking wave. The top elevation of the landward end of the groin would be 16.0 feet above mean low water. The intermediate sloped section will have the same steepness and slope as the proposed sandfill (15 on 1). This slope will continue until the 5 foot minimum top elevation is reached, where at this point the groin at the head of the structure will slope at a 2.0 on 1 slope. This new groin design will reduce reflection losses and save unnecessary rock usage. Each armor stone used for the groin structure is approximately 1,300 pounds with a maximum thickness of 2.5 feet. (See Plate 3-7)

MITIGATION REQUIREMENTS

There will be an impact on the soft clams in this area. Distribution of clams in the intertidal zone was determined by a clam survey on July 12, 1984. A pre-construction site survey will be conducted to determine the population densities at the beach. The beach will be reseeded at a ratio of 10:1 with seedlings, following construction. A follow up survey will be accomplished approximately one year later, to evaluate the success of the seeding. Construction activities are scheduled to be completed by July 1, avoiding the peak of the beach use and tourist traffic season.

ECONOMIC CRITERIA

Plans 2 and 3 would lead to a projected increase in both beach and park use. The economic evaluation was a regional analysis of the Belfast Area and is based on beach usage and prevention of loss of land.

A benefit-cost analysis was used to determine the most practical and economically feasible plan. The benefits and costs were estimated using October 1983 price levels and an interest rate of 8-1/8 percent. Detailed estimates of the plans of improvements are contained in Appendix 3.

Any Federally funded project must assure a return of at least one dollar of material benefit for every dollar spent on construction and maintenance of the project. This is determined by a benefit-cost ratio which must be greater than or equal to 1.00. Table 1-a and 1-b contain a summary of the benefit-cost ratios for Plans 2 and 3.

PLAN 2 AND PLAN 3

PLAN DESCRIPTION

These plans consists of beach widening to a level beach berm of 50, 75, or 100 feet to a backshore elevation of 15.0 feet above MLW (10.4 NGVD) by the direct placement of suitable sandfill along approximately 550 feet of shoreline on the western end of Belfast Bay. There will also be 20 feet of rock revetment north of the northern groin structure and 20 feet south of the southern groin structure (rock revetment is used where a structure is placed) to prevent scouring and erosion of the adjacent embankment. The top elevation of the groin structures and rock revetment is 16.0 feet mlw (11.4 NGVD).

Plan 2- Sandfill and construction of two terminal groin structures at the northern and southern limits of the beach.

Plan 3 - Sandfill and construction of a terminal groin structure at the northern limit of the beach.

IMPACT ASSESSMENT

Sandfill Impacts - Unconsolidated sand material at Belfast City Park Beach is transported from south to north. Based on past historic data, past surveys and knowledge of the littoral process in the area, it was determined that alongshore losses will be drastically reduced if a better quality of sandfill (material with fewer fines) were used. The selection of the fill to be placed on the beach will be based on the guidelines set in the 1977 "Shore Protection Manual". Every attempt will be made to obtain fill that will be compatible with the color and texture of the existing material. Also to enable a more accurate determination of sand movement in and around the beach, a series of post construction surveys and monitoring program would be scheduled. This would assist in comparing and evaluating the effects of a better quality of sandfill material and the effect of groin construction on sand movement.

The most serious impact is the temporary disruption of the bottom topography in the intertidal zone which could affect the nearshore environment. This adverse impact will be reduced by specifying that the proposed sandfill material reduces the percentage of fine material, thereby reducing the turbidity caused by the placement of the sandfill. The 15 horizontal on 1 vertical slope will reduce the extent to which the toe of the sandfill extends into the water. This foreshore slope will keep to a minimum the number of clams or other organisms that could be buried by the sandfill.

Shoreline Impacts - Due to the better quality (material with fewer fines) of sandfill that is proposed to be placed on the beach, the rate of erosion of the shoreline will be reduced. The proposed material to be placed on the beach will extend seaward from the existing backshore, approximately 112 feet to the mean high waterline for a 50-foot level berm, 135 feet for a 75-foot level berm, and 157 feet for a 100-foot level berm. This would provide much needed beach bathing space, and provide protection to the backshore park from storm-driven waves. Periodic nourishment is recommended to maintain the shoreline at or near design dimensions with either one or two structures. The normal alongshore and offshore sand movements were taken into account for this beach nourishment program. No adverse impacts except during construction are foreseen at Belfast City Park Beach on the adjacent shorelines for Plans 2 and 3.

Short-Term Impacts - The proposed sandfill will be placed along the backshore and then be distributed along the upper part of the intertidal zone by bulldozer, with natural tide action distributing the sand further seaward. It is anticipated that the majority of this material will stay within the limits of a groin structure(s). The beachfill will erode naturally through normal wave and tidal current action. The sand losses offshore and alongshore will be greatly reduced with a better quality of material (material with fewer fines). The natural tide and wave action will distribute the placed material and determine the slope of fill.

Impacts on the Marine Ecosystem - Intertidal habitat (all of which are considered to be soft clam habitat) and organisms would be destroyed. Sandfill and groins in the 75 and 100 foot berm plans extending further out, effects on organisms in the intertidal zone would range over incrementally more area and also extend into the nearshore zone. If only one groin were used, the less effective holding of the sandfill would cause further impacts on the nearshore zone, but would reduce clam habitat destruction in the intertidal zone by the surface area of one groin.

Long-Term Impacts - Long-term impacts would only occur as a result of the groin structure(s). The construction of the groin structure(s) would only affect the marine life directly beneath the structure(s) and the impact would only be minimal as new marine life will be attracted to the structure(s). The groin structure(s) would also reduce sand losses into the bay.

Economic Impacts - There are no significant adverse economic impacts as a result of the proposed beachfill. The impacts that result from the placing of suitable sandfill are mostly positive and any adverse impacts are short-term.

Social Impacts - Temporary disruption on local roads and increased noise and dust levels would result from construction of the project. These impacts would be greater for the wider berm width plans, and for the two groins vs one groin alternatives, as related to the total amount of material requiring transfer to the site.

EVALUATION AND TRADE-OFF ANALYSIS

Plans 2 and 3 will provide additional beach bathing space and protection to the backshore park area. Storm-driven waves will no longer erode the backshore area but will break seaward of the proposed sandfill. The trade off to this plan is that by constructing the project, additional benefits will be obtained through increased beach use and protection to the backshore park. Another trade-off is by shortening the beach length from 780 feet to 550 feet and not extending the beach beyond mean low water, the majority of clam habitat would remain undisturbed although a larger beach could economically be utilized. The primary inhabitants of concern for the soft clams will be temporarily reduced in population by construction of the sandfill and groin(s). However, mitigation by reseeding at the beach will take place and should permit a return to former population levels.

PUBLIC VIEWS

The majority of the public views expressed to date have been favorable with respect to the construction of this improvement.

IMPLEMENTATION RESPONSIBILITIES

Cost Allocation - One hundred percent of the cost of the project is allocated to the beach erosion control and backshore park damage improvements. There are no other components in the Federal project beyond sandfill, groin, and revetment construction.

The Federal Government is responsible for; within a $1,000,000 limitation which includes 70 percent of the first cost of construction including final plans and specifications, and 70 percent of the future periodic nourishment as required. If these costs are greater than the $1,000,000 limitation, the locals must assume all of the remaining costs. Groin structure and rock revetment maintenance is a non-Federal responsibility.

Non-Federal responsibilities - This recommended Federal beach erosion control study with Federal participation is subject to the conditions of non-Federal local cooperation as shown in the recommendations at the end of this section. In addition, the non-Federal interests are responsible for providing diversion of freshwater drainage runoff away from the beach.

COMPARISON OF DETAILED PLANS

Plans 2 and 3 will be compared to the without project conditions. The two plans require the placement of suitable sandfill with retention structure(s) that will supply the much needed dry beach space to satisfy the ever-growing demand at Belfast City Park Beach and provide backshore protection for the park.

Plan 3 utilizes a terminal groin structure at the northern limit of the beach and has fewer effects than Plan 2 as this plan utilizes terminal groin structures located at the northern and southern ends of the beach and are designed to compartmentalize the placed sandfill. The groin(s) will not cause any adverse effects to adjacent shoreline areas beyond the beach since there is little or no substantial material movement that is taking place beyond these limits. Plans 2 and 3 will provide for continuing healthful recreational beach use with periodic nourishment. These plans satisfy the problem and opportunity statements, benefit and cost requirements, and complies with the planning constraints.

Table 1-a and 1-b compares Plans 2 and 3 in detail. The costs and benefits are based on October 1984 price levels. An interest rate of 8-1/8 percent was used over the 50-year period of analysis. Plan 2, with the extra groin structure requires less periodic nourishment than Plan 3. This savings in periodic nourishment gives Plan 2 a greater B/C ratio and greater net benefits than Plan 3.

Environmental Comparison - Consideration was given to the natural process, preservation of the shoreline, offshore areas and the adjacent shore when developing plans for Belfast City Park Beach. Plan 3 would less effectively hold the sandfill, thus causing greater impacts on organisms and habitat in the nearshore areas than Plan 2. However Plan 3, would reduce permanent clam habitat destruction in the intertidal zone by the surface area of one groin. The wider berm-width alternatives of both Plan 2 and Plan 3 would incrementally cause greater impacts on organisms and habitat in the intertidal and nearshore zones, in comparison to the least wide berm width of 50 feet.

Care and consideration will be given to all marine life during construction. This will be done by placing a better quality of sandfill, containing fewer fine materials, on the beach, which will reduce losses from wave action and will result in less marine life being covered up by sediments. This will also maintain the present water quality of the area.

TABLE 1-a
BENEFITS AND COSTS FOR CONSIDERED PLANS (1)

Plan	Berm Width	Total Project First Costs	Annual Benefits	Annual Costs	B/C Ratio	Net Benefits
2	50	$363,000	$200,000	$ 40,900	4.9	$159,100
	75	$531,000	$242,000	$ 62,100	3.9	$179,900
	100	$726,000	$282,300	$ 86,500	3.3	$195,800
3	50	$321,000	$200,000	$ 41,500	4.8	$158,500
	75	$465,000	$242,000	$ 64,400	3.8	$177,600
	100	$628,000	$282,300	$ 89,700	3.2	$192,600

(1) Plan 2, the 50 foot Berm width was chosen as the selected plan because the 75 foot and 100 foot berm widths extend below mean low water, causing more significant impacts on marine organisms. Plan 3 was not selected because of the limited sand holding of one groin and the additional impacts on the nearshore zone resulting from this. This plan would reduce permanent clam habitat in the intertidal zone. The 75 foot and 100 foot long groin structures could impact the downstream areas by changing circulation patterns in the area since the structures extend below mean low water. Also, those structures could be structurally unstable. These reasons would violate the planning objectives and constraints established for the study area.

TABLE 1-b
COST APPORTIONMENT FOR CONSIDERED PLANS

Plan	Berm Width	First Cost Fed	First Cost Non-Fed	Annual Cost Fed	Annual Cost Non-Fed	Annual Periodic Nourishment Fed	Annual Periodic Nourishment Non-Fed
2	50	$254,100	$108,900	$28,100	$12,800	$ 6,900	$3,000
	75	$371,700	$159,300	$43,000	$19,100	$12,000	$5,100
	100	$508,200	$217,800	$60,000	$26,500	$17,000	$7,600
3	50	$224,700	$96,300	$28,800	$12,700	$10,100	$4,300
	75	$325,500	$139,500	$44,800	$19,600	$17,600	$7,600
	100	$439,600	$188,400	$62,500	$27,200	$24,800	$11,100

The Federal share in periodic nourishment, dune maintenance, cosntruction, and study cost for the period of analysis, cannot exceed the $1,000,000 limitation. Current estimates indicate that approximately $600,000 is available for the Federal share in periodic nourishment.

TABLE 2

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNTS	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
A. Plan Description				
1. Major Features	Eroding Beach	Loss of backshore, undermine of the pavilion.	Protection to the backshore, pavilion and provide a much needed beach.	Protection to the backshore, pavilion and provide a much needed beach.
2. Recreational Land Area	28.5 acres	Continuing loss of land at 1.0 ft./yr.	Maintain base condition and provide a protective beach.	Maintain base condition and provide a protective beach.
3. Level Beach Berm	10 Feet	Little or no beach and continuing erosion.	50'/75'/100'	50'/75'/100'
4. Beach Width Above MHW	10 Feet	Little or no beach and continuing erosion.	112'/135'/157'	112'/135'/157'
5. Ownership	City	City	City	City
6. Structures				
(a) Federal				
(1) Seawalls	None	None	None	None
(2) Groins	None	None	None	None
(3) Jettys	None	None	None	None

TABLE 2 (Cont.)

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
(b) Non-Federal				
(1) Seawalls	None	None	None	None
(2) Groins	None	None	None	None
(3) Jettys	None	None	None	None
7. Dry Beach Width Above MHW				
(a) Existing	None	Loss of fronting beach and backshore.	Same as without project.	Same as without project.
(b) Future				
(1) 50 ft. level berm	Restoration and protection.	Restoration and protection.	112 ft.	112 ft.
(2) 75 ft. level berm	Restoration and protection.	Restoration and protection.	135 ft.	135 ft.
(3) 100 ft. level berm	Restoration and protection.	Restoration and protection.	157 ft.	157 ft.
(c) Non-Structural	Continued erosion.	Continued erosion.	Move structures back.	Move structures back.
(d) Structures	Continued erosion.	Continued erosion.	Two groins.	One groin.
(e) Revetments	Continued erosion.	Continued erosion.	Two groins.	One groin.

TABLE 2 (Cont.)

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
B. Impact Assessment				
1. National Economic Development				
(a) 50 ft. level berm				
(1) Total Annual Benefits	None	None	$200,000	$200,000
(2) Total Annual Charges	None	None	$ 40,900	$ 41,500
(3) B/C Ratio	None	None	4.9	4.8
(4) Net Benefits	None	None	$159,100	$158,000
(b) 75 ft. Level Berm				
(1) Total Annual Benefits	None	None	$242,000	$242,000
(2) Total Annual Charges	None	None	$ 62,100	$ 64,400
(3) B/C Ratio	None	None	3.9	3.8
(4) Net Benefits	None	None	$179,900	$177,600

TABLE 2 (Cont.)

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
(c) 100 ft. Level Berm				
(1) Total Annual Benefits	None	None	$282,300	$282,300
(2) Total Annual Charges	None	None	$ 86,500	$ 89,700
(3) B/C Ratio	None	None	3.3	3.2
(4) Net Benefits	None	None	$195,800	$192,600
(d) Non-Structural				
(1) Total Annual Benefits	None	None		
(2) Total Annual Charges	None	None	Non-structural plans were considered, but written off as not feasible because they did not meet the problem and opportunity statements and the national objectives.	
(3) B/C Ratio	None	None		
(4) Net Benefits	None	None		

TABLE 2

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
2. Environmental Quality				
a. Air Quality	no impact	no impact	Moderate increase in dust levels during construction. Prolonged for wider berm widths.	
b. Archaeological Properties	"	"	None	None
c. Biological Resources	"	"	Disruption of aquatic ecosystem, benthic organisms, and soft clam habitat. Increasing with longer berms	
d. Water Quality	"	"	Temporary increase in turbidity during fill and construction phases. Increased for wider berms.	
e. Noise	"	"	Temporary increase in noise levels during construction	
f. Aesthetic Values	"	"	Will be improved through project construction	
3. Other Social Effects	NONE	cont'd erosion & loss of land	Temporary disruption of usual activity by construction activities. Increased beach recreational opportunities	
4. Regional Development	NONE.	" " "	Reduce deficiency of salt water recreational facilities in this metropolitan planning region. Increased commercial activities for local businesses and revitilizing old business.	

TABLE 2

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
C. Plan Evaluation				
1. Conforms to Planning Constraints and Concerns				
(a) Avoids Adverse Effects on Adjacent Shoreline	NO	NO	yes, impacts increase with berm widths	somewhat
(b) No Unreasonable Financial Burden on city	NO	NO	no, but increases with longer berm widths	
2. Acheives Problem and Opportunity Statements				
(a) Provides a Safe Recreational Beach	no	no	yes	yes
(b) Contributes to Economic Strength and Well-Being of the Area	no	no	yes	yes
(c) Preserves the Environmental Quality of the Area	yes	yes	yes, with clam mitigation	less than Plan 2
(d) Contributes to the Stability of the Beach	no	no	substantially	minimally

TABLE 2

SUMMARY COMPARISON OF ALTERNATIVE PLANS

ACCOUNT	BASE CONDITION	WITHOUT PROJECT	PLAN 2	PLAN 3
D. Public Response - Favorable	no response	no response	yes	yes
E. Implementation Responsibility	0	0	70% Federal Share and 30% Non-Federal Share	

Table 2, titled "Summary Comparison of Alternative Plans", is a general evaluation of considered plans of improvement and includes the without project condition. The table represents as overview of the determining factors in selecting the options of improvement for Belfast City Park Beach. This is accomplished by displaying the significant beneficial and adverse impacts. The table accurately evaluates the analysis that leads to a final decision.

RATIONALE FOR SELECTED PLAN

Plan 2 with a 50 foot level beach berm is selected for implementation since it provides the highest B/C ratio, is the best engineering solution, and causes the least adverse environmental impacts on the area. Although the 75 foot and 100 foot berms provide greater net benefits, they are environmentally more damaging than the 50 foot berm because the longer berm widths would adversely impact the offshore clam habitat and may impact adjacent shorelines. Plan 2 with the construction of two terminal groin structures located at the north and south limits of the project would reduce alongshore losses as well as compartmentalizing the sandfill. Detailed engineering analysis determined that Plan 2 is the best plan that will stabilize the existing beach and protect the backshore park from future erosion and damage. Plan 3 would only reduce alongshore losses to the north but would not help losses to the south. The rate of periodic nourishment would also be higher with Plan 3, resulting in higher annual charges for the project.

CONCLUSIONS

The proposed project has been reviewed and evaluated with the overall public interest in mind. The review included an evaluation of all pertinent data concerning the proposed plan of improvement. It also considered the stated views of other interested agencies and the concerned public, relative to the various alternatives in considering a beach erosion control improvement for Belfast City Park Beach, Belfast, Maine.

The possible impacts of the proposed alternative have been studied relative to engineering feasibility, environmental effects and economic factors as they relate to the regional, and national resource development and other social effects as they relate to the public interest. The details of these issues have been stated in the formulation of the plans of improvements and can be found in other sections of this report.

In summary, there are substantial benefits to be derived from providing a recreational beach erosion control improvement at Belfast City Park Beach.

Table 2, Summary Comparison of Alternative plans, is an analysis of the final two plans and how the final plan was selected. It presents the determining factors that underlie each final alternative plan by displaying the significant beneficial and adverse impacts. This table is utilized for the purpose of a trade-off analysis and final decision making.

It should be noted that the proposed improvement would temporarily disrupt the environment during construction and offset the clam resource at the beach. However, these impacts are not considered significant particularly in view of the proposed mitigation for soft clam losses is so stated in the Environmental Assessment and Finding Of No Significant Impact. The most significant known impact that would result if the plan is implemented was considered in our determination; but due to the significant recreational benefits attributed to this popular beach, it is concluded that the adverse environmental effects would be offset by the beach improvement in the overall economic growth of the region.

The proposed action, as developed in this report, is based on a thorough analysis and evaluation of various practicable alternative courses of action for achieving the stated objectives. Any adverse effects or impacts on the environment and adjacent shores as a result of the proposed improvement were evaluated based on current available information. Each plan was either abandoned or evaluated based on its merit in achieving the specified objective. The recommended action is consistent with national and regional policies, statutes, and administration directives, and should best serve the intended use and interests of the general public and the concerned agencies.

RECOMMENDED PLAN

The recommended plan of improvement for Belfast City Park Beach, Plan 2 entails beach widening by the direct placement of a suitable sandfill along approximately 550 feet of shorefront providing for a 50 foot wide level
beach berm at elevation 15.0 feet mean low water (10.4 feet NGVD) and a 112-foot wide dry beach above the mean high waterline. Also included is the construction of two terminal rock groin structures and rock revetment located on the northern and southern ends of the beach. This plan will provide the needed backshore protection and dry beach space to satisfy the demand.

Prior to this plan being implemented, the city must provide a backshore drainage system. This system will provide adequate drainage away from the beach for backshore freshwater runoff that is now partially causing erosion down the center of the beach. The drainage pipe could be routed into the groin structure.

RECOMMENDATIONS

The Division Engineer recommends the plan discussed in the previous section "Recommended Plan" as the most practical, economical and environmentally suitable plan of improvement for City Park Beach, Belfast, Maine. Approval of the beach erosion control project by the Chief of Engineers is recommended under the provisions of Section 103 of the River and Harbor Act of 1962, as amended. The approval, with such modifications that the Chief of Engineers may deem advisable, is estimated to have a total first cost of $363,000 which includes the cost of the first year of periodic nourishment. The total project, including periodic nourishment for the 50 year period of analysis is $883,000. This cost excludes the preauthorization cost which is currently estimated at $160,000.

I further recommend that federal participation be authorized in the amount of $254,100 or 70 percent of the first cost of construction of the project, which is estimated to be $363,000, and annual periodic nourishment for the 50 year period of economic analysis. The non-Federal share of the first cost is $108,900. (For detailed cost estimates, See Table 3).

TABLE 3
THE SELECTED PLAN AND THE NED PLAN

Item	Amount: Selected Plan	Amount: NED Plan
Length of project	780 feet	780 feet
Length of beachfill	550 feet	550 feet
Volume of initial beachfill (c.y.)	18,000	46,000
Volume of Periodic nourishment (c.y.)	1,100	2,800
Rock amount for groin structures and rock revetment (tons)	4,100	7,100
First Cost	$363,000	$731,000
Annual Cost		
Interest and Amortization	$ 30,300	$60,600
Periodic nourishment	$9,900	$25,200
Groin maintenance	$500	$500
Revetment maintenance	$200	$200
	$40,900	$86,500
Annual benefits	$200,000	$282,300
Net benefits	$159,100	$195,800
Benefit-to-cost ratio	4.9	3.3
Cost apportionment		
First cost		
Federal	$254,100	$508,200
Non-Federal	$108,900	$217,800
Annual cost		
Interest and Amortization		
Federal	$28,100	$60,000
Non-Federal	$12,800	$26,500
Periodic nourishment per year		
Federal	$6,900*	$17,600*
Non-Federal	$3,000	$7,600
Periodic nourishment for 49 of 50 years		
Federal	$338,100	$862,400
Non-Federal	$147,000	$372,400
Groin structures and revetment Maintenance per year		
Non-Federal	$700	$700
Groin structures and revetment maintenance for 49 of 50 years	$34,300	$34,300

* The Federal share in periodic nourishment, construction, and study costs cannot exceed the $1,000,000 Federal limitation. Current estimates indicate that approximately $600,000 is available for the Federal share in periodic nourishment for the selected plan and approximately $350,000 is available for the NED plan (which will be exceeded in 20 years).

This recommended Federal beach erosion control study with Federal participation is subject to the following conditions of local cooperation:

1. The local sponsor (city of Belfast) should agree that it will:

a. Contribute prior to construction, in cash, 30 percent of the first cost of construction, including the cost of plans and specificstions (total project costs are currently estimated to be $363,000); a final apportionment of first costs will be made after actual costs and values have been determined.

b. Assume full responsibility for all project costs in excess of the Federal cost limitation of $1,000,000, which includes the cost of construction, periodic sand nourishment for the 50-year period of analysis and all study costs.

c. Maintain continued public ownership of the park and shore and its administration for public use during the 50-year period of analysis of the project by establishing, prior to construction, a boundary control line which will separate public property from private property used for the realization of the public benefits upon which Federal participation is based.

d. Provide, without cost to the United States, all lands, easements, and rights-of-way necessary for project construction and subsequent maintenance of the project.

e. Hold and save the United States free from all claims for damages that may arise before, during or after prosecution of the work and subsequent maintenance of the project other than damages due to the fault or negligence of the United States or its contractors.

f. Maintain the protective measures during the economic life of the project as may be required to serve their intended purpose by contributing, in cash, 100 percent of the cost of groin and revetment maintenance and 30 percent of the cost of periodic nourishment for the 50 year economic life of the project. If the Federal limitation of $1,000,000 is reached, the non-Federal interests are responsible for 100 percent of the cost-periodic nourishment. The estimated amount of periodic sand nourishment is 1,100 cubic yards annually. Such contributions are to be made prior to each nourishment operation.

g. Control water pollution to the extent necessary to safeguard the health of bathers.

h. Provide, at no cost to the Federal Government, a drainage pipe to divert fresh water runoff from the beach that is currently taking place. The pipes may be routed into the groin structure.

i. Comply with the requirements of non-Federal cooperation specified in Sections 210 and 305 of Public Law 91-646, approved 2 January 1971, entitled the "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

j. Comply with Title VI of the Civil Rights Act of 1964 (78 Stat 241) and Dept. of Defense Directive 5500.11 issued pursuant thereto and published in Part 300 of Title 32, Code of Federal Regulations.

ACKNOWLEDGEMENT AND IDENTIFICATION OF PERSONNEL

This report was prepared under the supervision and management of the following New England Division personnel:

Colonel Carl B. Sciple, Division Engineer
Joseph L. Ignazio, Chief, Planning Division
John T. Smith, Chief, Coastal Development Branch
Thomas C. Bruha, Chief, Shore Protection Section

The study and report was developed by James G. Doucakis, Project Manager; John Reis prepared the engineering design material; Charles Wener and Debra Strickland prepared the hydrologic material; Joseph Horowitz prepared the environmental material; Steve Rubin prepared the economic material; Diana Halas prepared the social resources material; John Wilson prepared the cultural resources material; Frank Fessenden prepared the coastal processes material; and the Word Processing Center typed the report.

The New England Division is appreciative of the cooperation and assistance provided to this study by Fred Benson of the U.S. Fish and Wildlife Service; Peter Holmes of the U.S. Environmental Protection Agency; Susan Mello of the National Marine Fisheries Service; Walter Foster of the Maine Department of Marine Resources; and Don Witherill of the Maine Department of Environmental Protection. Very Special thanks is extended to Mr. David A. Maynard, City Manager of Belfast and to Mr. Norris D. Braley of Time & Tide, RC & D for their help in the study process.

APPENDIX 1

ENVIRONMENTAL ASSESSMENT, FONSI, AND 404 EVALUATION

BELFAST CITY PARK BEACH, BELFAST, MAINE

APPENDIX 1

ENVIRONMENTAL ASSESSMENT

FINDING OF NO SIGNIFICANT IMPACT
AND
SECTION 404(b)(1) EVALUATION

PREPARED BY:
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ENVIRONMENTAL RESOURCE SPECIALIST

Department of the Army
New England Division, Corps of Engineers
Waltham, Massachusetts 02254
January 1984

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I. Introduction

This document concerns the proposed beach erosion control project at Belfast City Park, Belfast, Maine. The study was undertaken by the New England Division (NED), U.S. Army Corps of Engineers under the authority of Section 103 - Beach Erosion Control, of the River and Harbor Act of 1962, as amended. It was initiated as a result of a letter request from the City Manager of Belfast, dated November 20, 1980. NED has examined environmental values as part of the planning and development of the proposed plan in compliance with the National Environmental Policy Act of 1969. The following sections provide an assessment of environmental impacts and alternatives considered and contains other applicable data to Section 404 Evaluation requirements.

II. The Study Area

Belfast City Park is located midway along the southwest side of Belfast Bay, approximately 30 miles south of Bangor and one mile south of Belfast Center (Plate 1). The park is a very popular city-owned recreational area. On the ocean side of the park is Belfast City Park Beach which is a rocky beach extending along the 780 feet of park shorefront, on a roughly northwest to southeast axis. The segment above mean high water is approximately 10 feet wide, comprising 7800 sqaure feet, and is mostly coarse sand overlain by cobble. The approximately 275 foot wide, 214,500 square foot, relatively flat foreshore area consists of predominantly cobble over coarse and fine sand in the southeastern portion, and predominantly gravel and cobble in the central and northwestern portions. Presently there exists no usable dry beach space above mean high water. The erosion rate at the beach is approximately one foot per year. The backshore area is protected by a nearly vertical embankment which is between eight and fifteen feet high. The water is currently undermining the base of the embankment during higher than normal high waters. There is evidence of very severe erosion during storm conditions. The backshore area consists of approximately 28.5 acres of publicly owned land which is bound to the north and south by private property. The park facilities include parking areas, a swimming pool, a ballfield, playground equipment, picnic areas, a bathhouse and restroom facilities.

III. Project Description

The selected plan proposes to provide a recreational beach area and protection against further erosion by fixing sandfill along approximately 550 feet of the existing beach, from the existing embankment, seaward, a distance of 50 feet (berm-width) at a height of 15 feet above mean low water (mlw), then sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 245 feet (see Plate 3-7). Approximately 18,000 cubic yards of suitable clean coarse sandfill (see sandfill criteria in Appendix 3) will be obtained from an upland site or sites and trucked to the beach for placement, requiring about 1500 truck trips for delivery. A rock terminal groin structure will be constructed at each end of the beach, extending perpendicularly from the existing embankment, seaward, a distance of 50 feet at a height of 16 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it reaches elevation 7.0 feet above mlw, whereupon the slope will change to 2 horizontal feet to 1 vertical foot until it meets the existing beach, approximately 2 feet above mlw, for a total groin length of approximately 195 feet. The width of the base of the groins will be 28 feet at the upper end of the beach, widening to 48 feet, then narrowing to 28 feet at the toe (see Plate 3-7). There will also be rock revetment along the backshore embankment extending a length of 20 feet to the north of the north groin structure and 20 feet to the south of the south groin structure to prevent scouring of the adjacent embankments. Approximately 3200 tons of rock will be required for groin construction, and 900 tons for revetment construction, and will be obtained from a local land source or sources and trucked to the site, requiring about 680 truck trips for delivery. Rock sizes would range from about one-half foot in diameter to 2.5 feet in diameter.

The proposed work would begin in late March of 1985 or 1986, and would take approximately one to three months to complete.

Renourishment of approximately 4,400 cubic yards every four or 50 years, fluctuating, depending on storm frequency and severity, would be placed on the beach to maintain it to specifications. It would be delivered above mean high water and allowed to work its way seaward.

IV. Purpose and Need for the Project

The purpose of the project is twofold: to restore a recreational beach where one no longer exists, but where the demand is clear; and to protect this beach and the existing popular backshore facilities from the effects of erosion.

City Park provides recreational opportunity for persons from all over Waldo County, as well as from Belfast. The only other saltwater public beach within the Belfast Urban Area is Lincolnville Beach, 12 miles to the south. Lincolnville Beach (500 feet long) is smaller than the beach at Belfast (780 feet long) and has no bathhouse facilities. It is also directly off U.S. 1, which Belfast's beach is not, and therefore attracts a significant proportion of tourist users. Improvement of the Belfast beach would be very desirable from the point of view of local users, who otherwise would have to use Lincolnville, or travel even further away. Only about one-fourth of the demand for usable beach is being met in the Belfast Urban Area by the underdeveloped Belfast Beach and the beach at Lincolnville.

Were the backshore area not to be protected from further erosion and undermining, the facilities thereon would become progressively more vulnerable to damage or loss, leading to possible disruption or abandonment of the well-established and popular recreational activities there.

V. Affected Environment

A. Marine ecosystem - The water quality in Belfast Bay in the vicinity of Belfast City Park is classified by the Maine Department of Environmental Protection as SB2 northwestward to just up to about the southeasterly limit of the park, at a point along the shoreline opposite the swimming pool. This represents the second highest category of water quality, with coliforms not to be in excess of 70 per 100 milliliters. These bacterial standards are acceptable for shellfish harvesting for direct consumption. Northwestward along the shore from opposite the swimming pool the waters are classified as SC - coliforms not to exceed 700 per 100 milliliters. In shellfish growing areas this bacterial count is too high for harvesting of shellfish for direct consumption, but they could be harvested and consumed after depuration.

A clam survey of the beach was conducted on July 12, 1984 with the Corps (Ernest Waterman and James Doucakis), U.S. Fish and Wildlife Service (Fred Benson), U.S. Environmental Protection Agency (Peter Holmes), National Marine Fisheries Service (Susan Mello) and Maine Department of Marine Resources (Walter Foster) participating. The results of the survey, prepared by Walter Foster, together with his comments, may be found in Appendix 5, Pertinent Correspondence. Follow-up correspondence from EPA and NMFS may also be found in Appendix 5. The survey indicated that a small population of the soft clam (*Mya arenaria*) exists at the beach, primarily located in three places: at the northern end of the beach, at the southern end of the beach, and at the center of the beach. The latter is apparently a transient population associated with an ephemeral ridge and runnel system migrating up the beach face. The northern population had been at the location of the proposed northern groin during the earlier planning stages, but the groins proposed location has since been moved southward, away from this area, due to the construction of a storm drain culvert at the earlier proposed location. The southern population is in the vicinity of the southern groin location. Numerous unoccupied clamshells were also found throughout the beach. A limited field reconnaissance for clams was conducted on September 20, 1983 by the Corps (Joseph Horowitz and James Doucakis), U.S. Fish and Wildlife Service (Fred Benson) and Maine Department of Marine Resources (Walter Foster). This earlier visit turned up evidence of the southern population that was found during the 1984 survey. Correspondence received shortly after this visit, from the Fish and Wildlife Service and the Maine Department of Marine Resources, may be found in Appendix 5, pages 5-15 and 5-18, respectively.

Concerning the low numbers of live clams found during the two visits, Foster suggests that the population may be at a cyclical low point resulting from the abundance of green crabs (*Carcinus maenas*), which are predators of the clams. The increase in the crab population is attributable to higher than normal water temperatures of recent years along the coast. A similar series of events occurred in the 1950's. (See An Ecological

Characterization of Coastal Maine, Volume 3, published by the U.S. Fish and Wildlife Service, Newton Corner, MA, 1980, P. 12-3,4). Also, the present physical state of the beach, with cobble and gravel predominating in the central and northwestern portions, was cited as a contributing factor to the low population.

Based on the above information, it would be appropriate to characterize the entire intertidal zone as clam habitat. Currently existing live clam resource, as evidenced by the 1983 reconaissance and the 1984 survey, may be ascribed to only three locations: to the north of the new location of the northern groin, at the center of the beach (a transient population), and in the vicinity of the southern groin.

Although the water quality classification at the beach technically would permit clam harvesting with depuration, the city of Belfast currently prohibits harvesting under an ordinance to manage the clam resource passed ten years ago in cooperation with four surrounding towns. According to Walter Foster, of the State Department of Marine Resources (Personal Communication), it is possible that as local abatement activities continue, the level of pollution may decline sufficiently in the next two decades to cause local officials to remove the harvesting ban at this location. Water quality in the area has improved significantly, with the sewage abatement process in the Penobscot River in recent years.

Other inhabitants of the intertidal zone at Belfast City Park Beach include barnacles, periwinkles and rockweed on the larger cobble, blue mussels and green crabs; scallops are found near the shore and lobsters, offshore in low concentration (U.S. Fish and Wildlife Service and Maine Department of Marine Resources-Personal Communication). Shorebirds visit the beach in small numbers.

B. Terrestrial ecosystem - The terrestrial ecosystem at Belfast City Park is mostly developed and well-used parkland, with roads, parking lots and various facilities spread throughout the Park area.

C. Threatened and endangered species - No threatened or endangered species utilize the study area for any purpose. This has been confirmed by a telephone conversation with Gordon Russell of the U.S. Fish and Wildlife Service, Concord, NH on December 8, 1983.

D. Archaeological and historical resources - There are no recorded prehistoric or historic archaeological sites within the project impact area. A field examination by the Maine Historic Preservation staff in 1982 confirmed that no such resources are present.

VI. Environmental Consequences

The proposed plan of placing sandfill along approximately 550 feet of beach, with a 50-foot berm-width, and building a groin structure at each end of the sandfill, with backshore revetments 20 feet long at each groin structure, would produce certain impacts. These can be generally divided amongst the impacts of the sandfill, of the groin structures, of the revetments, and of the construction process itself.

The toe of the sandfill is expected to be at about 2 feet above mean low water. Although it is unlikely that there will be significant washing down of the placed sandfill, due to its coarse nature, we might assume as a possible worst case that the entire foreshore or intertidal resource and habitat will be buried by sandfill, or 151,250 square feet of area, all of which we shall consider to be soft clam habitat, again as a worst case. It is likely that only the first few feet above mean low water will be repopulated by intertidal organisms, as the higher areas will be too dry to support them. Also, with greater use for recreation, even the lower areas may not provide high quality intertidal habitat. A positive impact could be realized as a result of the covering over of the considerable cobble in the intertidal zone, with sand, which may enhance the habitat in the portion of the intertidal zone that is not too high and dry. It is very unlikely that any significant amount of sand will move beyond the mean low water line, and no significant impacts to habitat or organisms below the mean low water line are expected. Construction of the two groin structures would permanently bury the surface area occupied by the groins, or about 11,600 square feet. About 11,000 square feet of the groins would cover intertidal habitat, all of which will be considered to be soft clam habitat. Thus, about 3.7 acres of intertidal habitat (all of which is considered to be soft clam habitat) and organisms would be destroyed due to the sandfill and groin structure placement, with some repopulation at the lower end of the sandfill. The only known non-transitory soft clam resource that would be destroyed would be that which is located at the southeasterly end of the beach, in the vicinity of the southern groin. The other known non-transitory soft clam resource would lie entirely to the north of the northern groin location. The backshore revetments would not bury any important habitat or organisms.

A preconstruction site survey will be conducted to determine the population densities of the soft clam at the beach. The beach will be reseeded at a ratio of 10:1 with seedlings, following construction. A follow-up survey will be accomplished approximately one year later to evaluate the success of the seeding.

Renourishment of 4,400 cubic yards of sand above mean high water every four or so years should not significantly affect the local marine ecosystem. The 4,400 cubic yards spread along the upper edge of 550 linear feet of beach would equal about 8 cubic yards per linear foot of beach. Schafer[1] reports that soft clams can escape from 10 cm. of sand in 2-10 hours. Sand washed down over live clams from above mean high water should not attain depths prohibiting escape. No permanent effects on any other organisms would be expected.

[1]Schafer, W., 1972. Ecology and Paleoecology of Marine Environment. (Ed.) G.Y. Craig, Trans. Chicago Univ. Press, 568 pp.

No significant impact on the water quality would be anticipated as a result of the project work; minor and short-term turbidity increases nearshore are possible during construction. No water quality impacts are expected to result from periodic renourishment.

Construction activities at City Park Beach would result in increased noise and dust levels, both at the site and along transportation routes for the trucking of sandfill and rock material. The total of 2180 truck trips would also prove to be a hindrance to traffic. However, scheduling of the construction activities, to be started in late March and completed in one to three months, should avoid even in the worst case the important post July 1 peak tourist season traffic. Recreational use of the park and beach would be limited during construction, but with completion expected before the peak of the beach use season (July and August), significant impacts would be avoided. All construction impacts would end with project completion. Minor construction-related effects (noise, dust, traffic, park and beach use) would be expected during periodic renourishment.

No short or long term effects on terrestrial resources are anticipated as a result of project implementation. No threatened or endangered species will be impacted by the proposed action.

As the Maine Historic Preservation Commission has confirmed that no significant historic or prehistoric resources are present within the project impact area, no effect upon such resources is anticipated due to project construction.

With project implementation, the positive impacts of significantly enhanced recreational opportunity at the beach, and protection of the beach and park facilities against erosion will be realized.

It is possible that, with project implementation, demand for use of the park facilities may exceed the capability to handle the demand. Expanded parking and other amenities may be deemed necessary and implemented and, if so, traffic in the vicinity of the park and on access routes to it may increase, large crowds could degrade the park use experience, limiting park use to some capacity number of people at one time could ameliorate the effects of excessive demand for use.

VII. Alternatives

The alternatives for this project include a "no action" alternative; sandfill of three different berm-widths, with no groins at all, and with differing groin schemes; and two alternatives involving no sandfill, with protection of the backshore area being the only purpose.

A. No Action Alternative - This alternative to the proposed work would avoid the impacts associated with project implementation, but would leave the beach in a continued essentially unusable state for most water-related recreation, and would expose the backshore facilities to increasing vulnerability to erosive processes.

B. (Plan 1) Sandfill only, with berm-widths of 50, 75 or 100 feet, with no containment structures - The sandfill would not be expected to remain on the beach, without containment, and therefore would not satisfy an important project purpose. The erosion rate at the beach is about one foot per year. This alternative was thus rejected. The disposition of the displaced sand away from the beach could impact marine habitat and organisms in the downdrift areas. The wider berm-widths would cause incrementally more significant effects due to the greater amount of sand involved as well as the greater coverage by sand of intertidal and nearshore habitat and organisms (including soft clam habitat in the intertidal zone) upon placement (sandfill in the 75 foot plan would extend to just below the mean low water line, or 300 feet from the embankment, and in the 100 foot plan to about - 5 mlw or 345 feet from the embankment). In addition, transportation impacts would incrementally increase for the wider berm-widths, but be somewhat less in each case than the same berm-width with groins.

C. (Plan 2) Sandfill, with berm-widths of 75 or 100 feet, with a groin structure at each end of the 550 foot beach - These variations of the selected plan comprise wider berm-widths and longer groins (groins of 250 foot length in the 75 foot plan and 305 foot length in the 100 foot plan). With sandfill and groins in the 75 and 100 foot plans extending further out, there would be incremental effects on organisms and habitat in the intertidal (including soft clam habitat) and nearshore zones. The groin at the southern end of the beach would destroy an existing soft clam resource. Transportation impacts would also incrementally increase due to the greater amount of material.

D. (Plans 3 and 4) Sandfill, with berm-widths of 50, 75, or 100 feet, but with only one groin structure, either at the northern or southern end of the beach - These alternatives would not effectively hold the sandfill, although they would hold the sand more so than with no groins at all. Impacts on the intertidal zone from physical replacement of existing habitat by rock would be less significant than in the selected plan and Plan 2 alternatives because of the use of one groin structure as opposed to two, but this would be counterbalanced by the impacts of release of the sandfill into the Bay. Construction of a groin at the southern end of the beach would destroy an existing soft clam resource, while construction of a groin at the northern end would not. Transportation impacts would be less than with the Plan 2 alternatives.

E. (Plan 5) No sandfill. Rock revetment along the backshore embankment - Although this plan would protect the park backshore area, it would not protect the existing unusable beach nor enhance the recreational opportunities at the beach. Approximately 50,000 tons of rock would be required. This would lead to about 8300 truck trips to the park - nearly four times the number as in the selected plan, with the attendant quadrupling of noise and traffic effects along the haul route and at the park. No significant negative impacts on the park ecosystem would be expected.

F. <u>(Plan 6) Construction of a 700 foot long (12 foot wide at the top, 152 foot wide at the bottom and 30 foot high) offshore breakwater in front of, and about 1000 feet offshore of, the beach</u> - Approximately 137,000 tons of rock would be required. The exorbitant project costs far outweigh the benefits of this alternative. This plan would decrease the current erosion rate, by about one-half, but would not improve the current state of the beach. Environmentally, the transportation of the rock material could be a significant impact, depending on the transportation route. Noise, dust and traffic effects would be the primary factors involved in the onland portion of the transportation route. About 22,800 truck trips would be required. The marine portion of the route could interfere with boat traffic. The placement of stones for offshore breakwater construction would cause a minimal amount of suspension and turbidity. The bottom material would settle out rapidly after each individual placement. Benthic organisms would be destroyed by construction of the breakwater, and benthic habitat would be lost and permanently changed to that of a hard rock surface. Species suited to the new habitat would occupy the breakwater.

VIII. Coordination

The city of Belfast initiated this study in a letter from the City Manager, dated November 20, 1980. Coordination with city officials has been taking place since the beginning of the study. The Corps of Engineers has also consulted with several resource agencies to gather information for the study and to keep them informed on its progress, including the U.S. Fish and Wildlife Service, Environmental Protection Agency, National Marine Fisheries Service and Maine Department of Marine Resources. All of the aforementioned participated in the clam survey held on July 12, 1984. Further coordination will take place during agency review of this document. Correspondence received to date may be found in Appendix 5, Pertinent Correspondence.

IX. Compliance with Federal Environmental Protection Statutes

The following table summarizes the relationship of this project to Federal Environmental Protection Statutes.

BELFAST CITY PARK BEACH, BELFAST MAINE

FINDING OF NO SIGNIFICANT IMPACT

The proposed beach erosion control project at Belfast City Park, Belfast, Maine would provide for the fixing of approximately 18,000 cubic yards of clean, coarse sandfill along approximately 550 feet of the existing beach, with a 50 foot wide berm extending seaward from the embankment where the beach joins the backshore area, at a height of 15 feet above mlw, then sloping at a rate of 15 horizontal feet to one vertical foot to approximately two feet above mlw, for a total sandfill width of approximately 245 feet. A 195 foot long rock terminal groin structure would be constructed at each end of the beach for the purpose of erosion control. The width of the base of each groin structure would range from 28 to 48 feet; depending on location along the length of the structure. There would also be rock revetment along the backshore embankment extending a length of 20 feet to the north of the north groin structure and 20 feet to the south of the south groin structure to prevent scouring of the adjacent embankments.

The proposed plan would provide a recreational beach area, where one does not now exist, and protect against erosion, both at the beach and at the adjacent backshore park.

Intertidal habitat (all of which is considered to be soft clam habitat) and organisms over about 3.7 acres' area would be destroyed. The only known non-transitory soft clam resource that would be destroyed would be that which is located at the southeasterly end of the beach, in the vicinity of the southern groin. Clam losses would be mitigated for by reseeding after construction, based on a preconstruction clam survey. Minor and short term turbidity increases nearshore are possible during construction. No effects are expected on terrestrial or historic and archaeological resources. Construction impacts would be minor, involving increased noise and dust at the project site and along the material haul routes and traffic effects along these same routes. Use of park facilities would be impaired during construction however construction and this impact would cease prior to the peak of the heavy-use summer season. No significant effects would be anticipated to result from periodic renourishment.

After a complete, in-depth study and with coordinaton from other agencies, I have determined that the proposed beach erosion control project will not have any significant impacts which would necessitate the preparation of an Environmental Impact Statement.

26 Apr '85
(Date)

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

SECTION 404(b)(1) FACTUAL DETERMINATION
AND FINDING OF COMPLIANCE
SMALL BEACH EROSION CONTROL PROJECT
BELFAST CITY PARK BEACH
BELFAST, MAINE

References

a. Section 404(b) of Public Law 92-500, as amended, Clean Water Act.

b. 40 CFR Part 230 Subparts A, B, C, D, E, F, G, and H dated 24 December 1980.

I. Project Description

a. Location

The proposed project is located at City Park Beach, Belfast, Maine, about midway along the southwest side of Belfast Bay.

b. General Description

The proposed plan consists of placement of approximately 18,000 cubic yards of clean coarse sandfill along approximately 550 feet of the existing beach, from the embankment where the beach joins the backshore area, seaward to approximately two feet above mean low water (mlw). A rock terminal groin structure would be constructed at each end of the beach for the purpose of erosion control. There would be rock revetment along the backshore embankment extending a length of 20 feet to the north of the northern groin structure and 20 feet to the south of the southern groin structure to prevent scouring of the adjacent embankments.

c. Authority and Purpose

The purpose of the project is to provide a recreational beach area, where one does not now exist, and protect against erosion, both at the beach and at the adjacent backshore park. Project authority is conferred in Section 103 of the 1962 River and Harbor Act, as amended.

d. General Description of Dredged or Fill Material

The sandfill material would be coarse, clean, free of any harmful contaminants and composed of naturally occurring sand from a suitable upland site or sites. Approximately 18,000 cubic yards of sandfill would be used. Approximately 4100 tons of rock would be used for constructing the groins and rock revetments, also to be obtained from an upland site or sites. Rock sizes would range from about one-half foot in diameter to 2.5 feet in diameter.

e. Description of the Proposed Discharge Site

The proposed discharge site can be found on Plate 3-7. It is about 3.7 acres of the intertidal zone at City Park Beach, Belfast, Maine, consisting of predominantly cobble over coarse and fine sand in the southeastern portion, and predominantly gravel and cobble in the central and northwestern portions, and another 0.1 acre above mean high water. Discharge would take place over a one to three month period beginning in late March of 1985 or 1986.

f. Description of Disposal Method

The sand and rock would be delivered by truck to the beach. The sand would be dumped above mean high water and then bulldozed onto the beach. The rock would be dumped at the location of the groin structure or revetment and be placed by a crane.

II. Factual Determinations

a. Physical Substrate Determinations

The proposed discharge site would be transformed from a combination of sand and gravel overlain by cobble to all sand, and at the two groin structures and revetments, to a rock substrate.

The substrate elevation and slope would be changed from a gently sloping area below the eight to fifteen foot backshore embankment to one characterized by a fifty foot sand berm extending seaward from the embankment, at a height of 15 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 245 feet; each of the two groin structures would extend perpendicularly from the existing embankment, seaward, a distance of 50 feet at a height of 16 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it reaches elevation 7.0 feet above mlw, whereupon the slope would change to 2 horizontal feet to 1 vertical foot until it meets the existing beach, approximately 2 feet above mlw, for a total groin length of approximately 195 feet. The width of the base of the groins would be 28 feet at the uppper end of the beach, widening to 48 feet, then narrowing to 28 feet at the toe.

The fill material would be clean, coarse sand and rock. Sand and rock would be obtained from an upland site or sites.

It is very unlikely that any significant amount of the sand will move below the mean low water line.

The placement of sandfill and construction of groins and revetments would bury about 3.7 acres of intertidal habitat (all of which is considered to be soft clam habitat) and associated organisms. The only known non-transitory soft clam resource that would be destroyed would be that which is located at the southeasterly end of the beach, in the vicinity of the southern groin. No significant impacts to habitat or organisms below the mean low water line are expected.

b. Water Circulation, Flucutation and Salinity Determinations

Current patterns, circulation, normal water fluctuation and the tidal regime would not be altered in such a manner as to result in adverse impacts on the environment. Construction of the groins should result in no significant effect on areas surrounding the beach, either updrift or downdrift, as there is currently very little littoral material moving in the area. The groins will hold the sandfill at the beach in place, thus keeping it from entering the adjacent system.

Chemical and physical characteristics, including salinity, pH, dissolved oxygen levels, nutrients, clarity, color and odor would not be permanently changed from present conditions. There would be no introduction of nutrients that would result in the possibility of increased eutrophication.

c. Suspended Particulate/Turbidity Determinations

As a result of construction, a temporary minimal increase in suspended particulate and turbidity levels is expected. Any sandfill material would settle out quickly due to the large grain size of the sand. The discharge would not violate such water quality standards as are appropriate and applicable by law.

Chemical and physical properties of the water column would not be adversely affected. Light penetration may be temporarily reduced due to minor increases in turbidity. Dissolved oxygen levels should not be reduced by the proposed discharge. There would be no introduction of toxic metals or pathogens and organic loads would not increase.

The processes of primary production and photosynthesis would not be adversely affected by any increases in suspended particulates. Suspension and filter feeders would also not be adversely affected because of the minimal amount of material expected to enter the water column.

d. Contaminant Determinations

All material proposed for discharge would be clean. It would come from a suitable inland source or sources. It would be free of harmful contaminants that might adversely impact the aquatic environment or render the beach unsuitable for human use.

e. Aquatic Ecosystem and Organism Determinations

Intertidal habitat (all of which is considered to be soft clam habitat) and organisms over about 3.7 acres' area would be destroyed. The only known non-transitory soft clam resource that would be destroyed would be that which is located at the southeasterly end of the beach, in the vicinity of the southern groin. Based on a preconstruction clam survey of the beach, reseeding will take place at a ratio of 10:1 following construction.

Discharge of clean sandfill would not significantly disrupt the chemical, physical or biological integrity of the aquatic ecosystem below the mean low water line. The food chain would not be significantly disrupted in such a manner as to alter or decrease diversity of plant or animal species below the mean low water line.

No Federally listed threatened or endangered species would be impacted by the proposed discharge.

f. Proposed Disposal Site Determinations

A high degree of mixing would be expected nearshore as the project is located in a high energy environment due to the open exposure of the beach and its situation adjacent to the surf zone. Also, only coarse sand will be placed at the beach, and it is expected to remain there.

The placement of clean, coarse sand on the beach and construction of groins and revetments would not violate such water quality standards as are appropriate and applicable by law, as the only effect expected on the nearshore waters is a temporary minimal increase in suspended particulate and turbidity levels during construction.

Municipal and private water supplies would not be adversely affected by the proposed discharge.

Soft clam habitat over about 3.7 acres' area would be destroyed. An existing soft clam resource located at the southeasterly end of the beach in the vicinity of the southern groin would also be destroyed. Reseeding of the beach in a ratio of 10:1 will take place after construction, based on population densities to be determined by a preconstruction survey.

Water-related recreation would be substantially improved by the proposed discharge, which would result in a recreationally inviting swimming beach at City Park.

The aesthetics at the beach would be temporarily degraded during construction, but the positive aspects of the resulting project would far outweigh this short term effect. Temporary construction features would include the heavy equipment in use (trucks, bulldozers, crane), probably a staging area for heavy equipment, a construction office and piles of sand and rock.

No parks (other than City Park - the benefactor of the proposed discharge), national or historical monuments, national seashores, wilderness areas, research sites or similar preserves would be affected in any way by the proposed discharge.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

There would be no cumulative effects on the aquatic ecosystem.

h. Determination of Secondary Effects on the Aquatic Ecosystem

There would be no secondary effects on the aquatic ecosystem.

FINDING OF COMPLIANCE
FOR
BELFAST CITY PARK BEACH, BELFAST, MAINE
SMALL BEACH EROSION CONTROL PROJECT

1. No modifications of the Section 404(b)(1) guidelines have been made in preparation of this evaluation and supporting documents.

2. A detailed discussion of the rationale for selection of the proposed plan can be found in the main report (see pg. 22). There is no practical or economical alternative to the proposed discharge which would have less impacts on the aquatic ecosystem and be capable of achieving the basic purposes of the proposed project, which are creation of a recreational beach area and protection of the beach and the backshore park against erosion. Alternatives with no groins or one groin would not adequately hold the sandfill in place, thus leading to impacts on nearshore and offshore habitat and organisms. Wider berm-widths and longer groins would increase the area of coverage of the sandfill and groins and lead to incremental effects on intertidal and nearshore habitat and organisms. Rock revetment at the backshore and offshore breakwater alternatives would not satisfy the project purpose of creation of a recreational beach. The 'no action' alternative would not satisfy the project purpose of creation of a recreational beach, and would permit continued erosion of the existing beach and backshore area.

3. The proposed discharge would not violate any applicable State water quality standards. The Toxic Effluent Standards of Section 307 of the Clean Water Act would not be violated.

4. The proposed discharge would not harm any species listed as threatened or endangered or their critical habitat under the Endangered Species Act of 1973. The Marine Protection, Research and Sanctuaries Act of 1972 is not applicable.

5. The proposed discharge would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife and special aquatic sites. The life stages of aquatic life and other wildlife would not be significantly adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values would not occur.

6. Appropriate steps to minimize potential adverse impacts of the discharge on the aquatic ecosystem include the use of clean, coarse sand as the discharged sandfill, being of appropriate grain size to minimize movement after placement, the construction of groins to keep the sand in place, and reseeding of clams at the beach after construction.

7. On the basis of the guidelines, the proposed disposal site for the discharged material is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

Statement

The proposed site for the discharge of sandfill material at City Park Beach, Belfast, Maine has been specified through the application of the Section 404(b) Guidelines.

The project files and Federal regulations were reviewed to properly evaluate the objectives of Section 404(b) of Public Law 92-500, as amended. A public notice with respect to the 404 Evaluation will be issued accompanying this document. Based on information presented in this Section 404 Evaluation, I find the project would not result in unacceptable impacts to the environment.

26 Apr 85
(Date)

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

APPENDIX 2

COASTAL PROCESSES

COASTAL PROCESSES

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APPENDIX 2
COASTAL PROCESSES

GEOLOGY

The project area is located along a 780-foot reach of eroded shoreline fronting Belfast City Park and facing easterly to Penobscot Bay. The beach consists of cobbles and sand derived from adjacent glacial till. The dry beach width is non-existant at high water and extends to 240 feet at mean low water. A small stream, probably of a "flashy" nature, crosses the beach near the south end of the project. A moderate slope of till covered backrock rises in back of the shoreline. This section of the report will discuss the geologic setting of the study area.

BEDROCK GEOLOGY

The bedrock underlying the area near Belfast City Park has been mapped as undifferentiated meta-sedimentary rocks of Ordovician-Silurian Age. The rocks were formed about 450 million years ago as sediments accumulated to great thickness in ocean basins. The sedimentary rocks so formed were then metamorphosed as the sequence underwent intense folding and uplift. A long period of weathering and erosion followed the metamorphism and deformation of the region. During this time the land generally wore down, the surface was leveled, and the present bedrock topography was sculpted. The period of weathering and erosion was halted about two million years ago by the world-wide climatic change which resulted flows from the north of great masses of ice over Maine and much of upper portions of North America. This period of glaciation, called the Pleistocene Epoch, has had a significant effect on the present day coastal landforms of the Belfast area.

SURFICAL GEOLOGY

The unconsolidated sediments lying over the bedrock in the study area are a direct result of the several episodes of glaciation occurring during the Pleistocene. The events of the most recent substage of the Pleistocene, the Wisconsin stage, have had the most immediate effect on the area and are the most confidently inferred from existing field evidence.

The Wisconsin ice began to advance towards the area no more than 100,000 years ago and had completely left Maine approximately 10,000 years ago. As the ice sheet advanced from the north it moved great quantities of previously weathered material with it and further eroded the bedrock surface. The erosion and deposition of the ice sheet shaped and strongly influenced the form of the present day topography.

Ice of the Wisconsin stage reached its maximum advance at about 18,000 years ago. Due to incorporation of water into the ice sheet, sea level at the time was substantially lower than at present and the ice advanced into the gulf of Maine on to the continental shelf. A general climatic warming began approximately 13,000 years ago and the ice sheet began to retreat from southeastern Maine. The rate of retreat of the ice front margin has been estimated at 300 yards per year.

Large quantities of sediment transported by the advancing glacier were deposited in the study area. Deposits of till range from compacted fine grain sands and gravels to loose sandy deposits containing boulders. The USDA Soils Conservation Service has classified the soil in the project area as Woodbridge-Paxton stoney phase. This classification describes the till as extremely stoney, with very low permeability and a firm surface texture.

Approximately 13,000 years ago, as the ice retreated from southeastern Maine, the sea level rose in immediate reponse to the ice melting and advanced inland, flooding the present mainland to a depth of 400 feet above present sea level. During this late glacial time, melt water streams transported large amounts of fine grained silt and clay into the ocean where they eventually settled to the bottom. This deposit of fine grained marine sediments has been named the Presumpscot Formation and underlies much of the coastal area of southeastern Maine. Post-glacial emergence or "rebound" of the land has exposed large areas of this glacial marine clay and other fine grained material. Several local readvances of the ice sheet along with late glacial outwash deposits have caused glacial drift to overlie the Presumpscot formation in several localities. Rising sea level has caused many of these deposits to be flooded. The surficial map of the Castine quadrangle shows the study area as overlain with till with Presumpscot sediments found north and south of Belfast. For purposes of this report it is sufficient to note that sands, gravels, and cobbles of glacial origin are present in and around the study area, and it is these eroded and reworked sediments that are present along the shoreline.

PRESENT SHORELINE

The present configuration of the beach and its location relative to surrounding land masses and bodies of water is due to several geologic factors including the glacially modified structure and topography of bedrock and the effects of rising sea level. Prior to the advance of glacial ice over the region the long period of uplift and erosion referred to earlier resulted in a bedrock surface which sloped seaward and was incised by several well developed stream valleys. The surface of the southeastern Maine coast (including specifically that of the Penobscot Bay area) was characterized by hills and moderate highlands separated by stream carved valleys.

As the ice spread over the area most of the valleys were enlarged by glacial scour. Great melt water streams draining the wasting glaciers at the close of the Wisconsin stage further eroded many of the valleys. The post glacial rise in sea level caused many of the valleys to become flooded. Hills and highlands on previously dry land became isolated islands in bays and coves. Almost the entire Maine coastline took on a very embayed and irregular appearance as the sea advanced landward.

Penobscot Bay with its several islands and capes, such as Castine, Cape Ellison, Sears Island and Islesboro is the result of a major river valley system being "drowned" by rising sea level. The Passagassawakeag River with Belfast Harbor at its mouth is a similar example on a smaller scale. Belfast City Park and Beach is located on a straight stretch of shoreline which is controlled by linear structural trends in the bedrock. The wave erosion and winnowing of the till overlying the bedrock has produced the specific surficial appearance of the beach. The drowned Penobscot valley and associated islands onto which the beach faces permit only very short fetches of onshore winds. The maximum fetch is to the east and is only 8.5 miles long. These short fetches suggest a low wave regimen and thus only a moderate overall rate of shoreline retreat due to wave attack. Intense storms of even short duration, however, can cause significant erosion for intermittent periods.

In summary, Belfast City Park Beach evolved as a result of the geolgic processes described above. The beach consists of sand, gravel and cobbles derived from erosion of glacial till. The shoreline is straight and faces a relatively narrow bay which is occupied by several capes and islands. The several fetch distances are quite short which tend to minimize the average long term wave energy impacting on the shoreline. Erosion of the unconsolidated till sediments is evidenced however, by the lack of dry beach area at high tide and a 5 to 10 foot embankment at the backshore. Further evidence of erosion is seen in damage to structures such as stairways. No information is available regarding the rate of retreat of the shoreline.

COASTAL PROCESSES IMPACTING THE STUDY AREA

OVERVIEW

The action of winds, waves, tides, and currents are the basic natural elements working to modify and reshape the configuration of coastlines. The dominant force occuring at Belfast City Park Beach is the action of wind generated waves. This section will discuss the effects of wind and waves on the erosion, deposition, and general sediment transport in the study area. Available information on any other natural processes impacting the study area will also be included.

WINDS

Waves affecting beach erosion and sediment movement at Belfast City Park Beach are caused by winds. Wind generated waves are influenced by the following three factors: wind velocity, fetch (length of open water over which the wind blows), and wind duration. Generally speaking, a longer fetch allows for longer lasting, higher waves of longer duration.

Because of its location on the west side of Penobscot Bay, City Park Beach is affected only by onshore winds ranging from N to SE. The fetch is limited by the narrow width of upper Penobscot Bay and the several large islands and capes found in the bay. The minimum fetch is 0.8 miles to the NNE and the maximum is 8.5 miles to the E.

Wind velocity has been monitored at Portland, Maine. Wind velocity measurements (one minute average wind speed data record in one hour intervals) were recorded at Portland for the years 1948 through 1965. Analysis of this data indicate that the onshore winds with the greatest frequency of occurrence are from the North. The magnitude of the average wind speed was similar from all directions ranging from 7.2 mph to 9.2 mph. The greatest maximum windspeed was 49.2 mph from the ESE, and the lowest maximum wind speed was 33.8 mph from the NE and ENE. Table 2-1 shows the percentage of occurrence and fetch distances of the onshore winds influencing Belfast City Park Beach. Table 2-2 shows th percentage of occurrence of onshore winds for several velocity ranges.

A study of wind speed, duration, and direction for the period 1948 through 1965 was performed on the data from Portland. Eighteen years of records are included in that period. The results of this study were expressed in tabular form and related duration in hours to class intervals of wind speed for given directions. The analysis further showed the actual number of occurrences of a given speed class interval during each duration period and also listed the average wind speed in each class-duration data cell. (See Appendix 3)

TABLE 2-1

PERCENTAGE OF OCCURRENCE AND FETCH DISTANCES

Direction	Percentages of Occurrence	Fetch (Miles)
N	33	0.9
NNE	18	0.8
NE	10	1.1
ENE	9	3.1
E	14	8.5
ESE	9	6.6
SE	7	5.6

TABLE 2-2

PERCENTAGE OF OCCURRENCE OF ONSHORE WINDS

Direction	0-15 MPH	0-25 MPH	>15 MPH	>25 MPH
N	33	32	29	20
NNE	17	18	24	10
NE	10	10	11	10
ENE	9	9	13	30
E	14	14	15	30
ESE	10	9	5	--
SE	7	7	3	--

This analysis was used to evaluate onshore wind speed and duration at Belfast City Park Beach. Wind sets of average of >15 mph and >25 mph and with durations of at least one and two hours were considered. Average speed/duration data and number of occurences for wind directions from N to SE were used to compute the annual frequency of occurence for the various wind duration sets by dividing number of occurrences by years of record. Table 2-3 lists the number of occurrences and annual frequencies of the several wind-duration sets considered.

Figure 2-1 illustrates in vector form the direction and magnitude of the annual frequencies of occurrence of winds >15 mph and >25 mph for durations of at least one hour. Figure 2-2 illustrates similar data for winds with durations of at least two hours. This vector diagram clearly show that the dominant high direction is from the ENE and E and the more gentle winds are from the N and NNE directions.

In summary, the principle onshore strong wind direction is from the E-ENE, and the principle less strong winds direction is from the N. The overall resultant wind direction is from the NE at an average resultant speed of 8.4 mph. Winds exert little direct impact on sand movement at Belfast City Park Beach. No quantitative data ia available for the most probably very small amount of sand moving directly by wind in the area. It is in the generation of waves that winds most directly impact the study area.

WAVES

The only significant waves affecting Belfast City Park Beach are wind-generated. The size of these waves is a function of fetch distance, water depth, and the magnitude and direction of sustained wind speed. Because of the location of the study area, waves impact upon it only in an arc ranging from N to SE. Wind-generated waves erode the shoreline by moving sediment on and offshore and by moving sediment along the shoreline. This last type of sand movement is termed longshore transport. In this section the nature of beach erosion due to wave action will be considered and discussed.

TABLE 2-3

NUMBER OF OCCURRANCES AND ANNUAL FREQUENCY
OF CERTAIN WIND-DURATION SETS

Wind Direction	Number of Occurances		Annual Frequency	
Wind set:	>15 MPH	$\geq$ 1 hr	($\geq$ 2 hr) Duration	
N	617	(182)	34.3	(10.1)
NNE	526	(169)	29.2	(9.4)
NE	238	(66)	13.2	(3.7)
ENE	241	(96)	13.4	(5.3)
E	287	(114)	15.9	(6.3)
ESE	143	(50)	7.9	(2.8)
SE	101	(34)	5.6	(1.9)
Wind set:	>25 MPH	$\geq$ 1 hr	($\geq$ 2 hr) Duration	
N	17	(6)	0.94	(0.33)
NNE	12	(3)	0.66	(0.16)
NE	7	(1)	0.38	(0.06)
ENE	26	(10)	1.4	(0.55)
E	31	(12)	1.7	(0.67)
ESE	13	(1)	0.72	(0.06)
SE	9	(3)	0.50	(0.16)

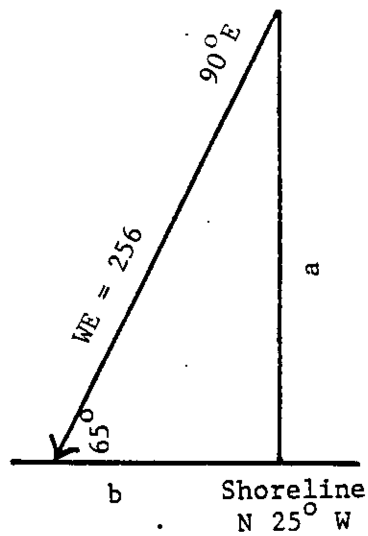
Conclusions regarding the natural trends of beach erosion on the study area will be drawn, and the results will be applied toward a consideration of the potential effects of beach nourishment and other shoreline modifications.

A vector analysis of winds impacting the shoreline and their frequency of occurrence was performed to arrive at a generalized quantitative estimate of potential sand movement by waves from different directions. In that winds from the various onshore directions will strike the beach from different angles, their effects will differ. By manipulation of data, a theoretical "ideal" orientation of the beach can be determined at which the least amount of erosion would occur.

The winds considered in this analysis were in the sets: $\geq$ 15 mph and $\geq$ 25 mph. The percent occurrence of winds of various speeds were previously determined for each of the seven wind directions affecting the study area (see Table 2-2). This percentage occurrence was multiplied by the corresponding fetch to obtain an <u>index of wind effectiveness</u>. For example, of all winds $\geq$ 25 mph impacting on the beach, 30 percent are from the E. The fetch distance from that direction is eight and one-half miles. The product of fetch distance (8.52 miles) and percent occurrence (30) gives a wind effective index of 256. The purpose of the wind effectiveness index is to incorporate the two factors of frequency and potential strength (velocity and fetch) into the analysis.

For each wind direction, a component with a value equal to the wind effectiveness index was resolved into an alongshore component and an onshore component. Figure 2-3 illustrates the vector resolution for a wind $\geq$ 25 mph from the E.

FIGURE 2-3



b = alongshore component
a = on/offshore component
Cos 65° = b/256
b = 108

The alongshore component for winds $\geq$ 25 mph from the E has a value of 108 to the north. In a similar fashion, values for winds $\geq$ 25 mph and $\geq$ 15 mph for each wind direction were calculated. The absolute value of the components has little meaning. The relative values are significant. The larger the alongshore value, the greater is the wave erosion expected from that particular wind direction. The various components were calculated for each wind direction, and the results were compiled.

Table 2-4 illustrates wind effectiveness values, and alongshore components for winds $\geq$ 25 mph from the several wind directions at Belfast City Park Beach. Also shown is the resultant total which can serve as a comparative value for expected alongshore transport at this level of wind. Table 2-4 illustrates the same parameters and resultant total for winds $\geq$ 15 mph.

Table 2-4 shows that under both wind conditions analyzed ($\geq$ 25 mph - net effect is 87.2 to the North; $\geq$ 15 mph net effect is 56 to the North) the net longshore transport component is to the North. This can be interpreted as meaning that at Belfast City Park both wind conditions (strong and gentle) tend to move beach sediments in a northerly direction. The very low valves of the resultant components are significant and suggest a low level of alongshore movement.

The figures in this vector analysis can be massaged to determine the beach orientation which would result in the least potential longshore transport. For stronger winds (≥ 25 mph) a beach orientation of N 11° W would result in very minor potential longshore transport as determined by vector analysis. For lighter winds (≥ 15 mph) the null littoral drift condition would be also achieved with a beach oriented at N 11° W. These results suggest that natural wind and wave processes are attempting to shape the beach into a stable oreientation of N 11° W. The existing orientation of the beach is N 25° W. The small difference between actual and theoretical beach configuration suggests that little change in beach orientation will occur in the near future.

TABLE 2-4

VALUES ON ONSHORE WIND EFFECTIVENESS
AND CORRESPONDING ALONGSHORE COMPONENTS

Winds > 25 MPH

Wind Direction	Wind Effectiveness Value	Alongshore Component
N	17.6	16 to South
NNE	7.8	5.2 to South
NE	10.7	3.6 to South
ENE	93.9	4.1 to North
E	256	108 to North
ESE	---	---
SE	---	---
	Resultant:	87.2 to North

Winds ≥ 15 MPH

Wind Direction	Wind Effectivenes Value	Alongshore Component
N	25.5	23 to South
NNE	18.7	13 to South
NE	11.8	4.0 to South
ENE	40.7	1.8 to North
E	128	54 to North
ESE	33	24 to North
SE	16.8	16 to North
	Resultant:	56 to North

WAVE HEIGHT AND FREQUENCY

Several analyses and techniques were employed to arrive at reliable planning estimates of the values of height and frequency of waves likely to impact the shoreline of the study area. Possible significant wave heights were determined for each onshore wind direction. The number of occurrence per year and the percent occurrence of waves of given heights from each onshore direction was also determined. Using this data, a table summarizing the annual frequency and percent occurrence of design wave by direction and wind return period was prepared.

POSSIBLE SIGNIFICANT WAVE HEIGHTS

Using data supplied in the Hydrology Report (see Appendix 3), wind velocities with a duration of one hour and an expected return period of ten years were complied for each onshore direction. The one hour duration time was selected because of the low fetch lengths present in the vicinity of Belfast City Park. The shallow water wave forecast curves (as modified from the Shore Protection Manual) furnished values for wave heights and period for the selected velocities. These figures are displayed in Table 2-5.

The information displayed in Table 2-5 is limited in that it gives no indication of the frequency of occurrence of the given waves. To acquire that information, values of wind velocity and duration required to support waves of various heights were gathered, and the annual frequency of their occurrence was calculated using data in the Hydrology Appendix. Using the 30 foot shallow wave forecasting curve (the 20 ft. shallow wave forecasting curve was used for the N, NNE and NE directions because of the short fetches and shallower depths found there.) and a general lower limit of 15 mph velocity and 30 minute duration (less for directions with a one mile or less fetch distance), various combinations of wind velocity and duration required to support waves of one foot and greater in height were determined. Data on number of occurrences and percentage of onshore winds has then been used to determine the occurrences per year of the velocity and duration values gathered from the shallow water forecast curves. The values for annual number of occurrences were summed and converted to percent occurrences. These values are shown in Table 2-6.

TABLE 2-5
POSSIBLE SIGNIFICANT WAVE HEIGHTS

Direction	Fetch (miles)	Winds of 1 hour duration and 10-year return period (MPH)	Possible significant wave heights and periods: Heights(ft)	Periods(sec)	Limiting Factor
N	0.9	34	1.3	1.8	Fetch
NNE	0.8	30	1.0	1.7	Fetch
NE	1.1	30	1.2	1.8	Fetch
ENE	3.1	33	2.1	2.6	Fetch
E	8.5	40	4.1	3.8	Fetch
ESE	6.6	37	3.3	3.4	Fetch
SE	5.6	35	3.0	3.3	Fetch

Possible significant wave heights from winds with a duration of one hour and an expected return period of ten years; wave heights gained from 30 foot depth shallow water wave forcasting curve, (wave heights, for N, NNE and NE gained from 20 feet shallow wave forcasting curve).

TABLE 2-6

ANNUAL FREQUENCY AND PERCENT OCCURENCE OF WAVE HEIGHTS BY DIRECTIONS

Direction	N			NNE			NE			ENE			E			ESE			SE			Total	
Fetch (miles)	0.9			0.8			1.1			3.13			8.5			6.6			5.6				
Wave Height (feet)	A[1]	%[2]	D[3]	A	%	D	A	%	D	A	%	D	A	%	D	A	%	D	A	%	D	A	%
1	19.8	0.5	<1	0.6	0.8	<1	0.3	0.4	<1	7.4	10.2	<1	42.2	58.4	1-2	9.2	12.7	1-2	5.6	7.7	1-2	65.7	90.7
2	N/A	N/A		N/A	N/A		N/A	N/A		0.7	1.0	<1	3.0*	4.1	1-2	0.9	1.2	1	0.3	0.4	1	4.9	6.8
3	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A		1.0	1.4	1	0.5	0.6	1	0.2	0.2	1	1.6	2.2
4	N/A	N/A		N/A	N/A		N/A	N/A		N/A	N/A.		.05	0.1	1							.1	.1
Total A	0.4			0.6			0.3			8.1			46.3			10.5			6.1			72.3	
Total %	0.5			0.8			0.4			11.2			64.0			14.5			8.3			100.0	

NOTES: [1] A = Annual Frequency

[2] % = Percent Occurrence

[3] D = Duration (hours)

* Example: A wave train of 2 ft in height from the east with a duration of 1-2 hours is expected to occur 3 times a year or 4.1 percent of the time that onshore winds are blowing.

Table 2-6 shows that at Belfast City Park winds from the N, NNE and NE exert little effect on the beach, winds from the ENE, ESE and SE has a moderate effect and winds from the East exert the major influence. It is only from the East that wave trains of greater than one foot in height are generated with a frequency of more than one time per year. This analysis also shows that 64 percent of winds that generate waves of one foot or more are from the East.

Table 2-6 also shows that 91% of the waves genereated by onshore winds at Belfast City Park are equal to or greater than 15 mph in velocity and 30 minutes duration are one foot or less in height. While this percentage number is only an estimate, it does serve as a clear indicator of the low wave height regimen operating in the study area.

DESIGN WAVE

Design waves were selected for each of the several onshore wind directions and for different wind return periods. The selection was performed according to procedures outlined in ETL 1110-2-305 dated February 1984. Adjusted annual and maximum wind speeds, for various durations and expected return periods were obtained from the Hydrology Appendix. Design waves are chosen with the use of wind speed-duration curves in conjunction with wave forecasting curves. For each onshore wind direction wind velocity-duration ordered pair curves were developed. Additionally, a velocity-duration curve for each wind direction fetch was developed. Those curves were then plotted and the design wind velocity was taken from the point of intersection of fetch curve and the given return period curve. Figure 2-4 illustrates these plots.

Once the design wind velocities for each wind direction was determined, the 30-foot shallow wave forecasting curve was used for the N, NNE and NE direction. Reference to Table 2-6 supplied the number of occurrences per year and the percentage occurrence for each design wave. Maximum wave heights range from 3.0 feet to 4.0 feet. The largest wave to occur more frequently than one time per year has a height of 2.4 feet. The results of this design wave analysis are seen in Table 2-7. The data from Table 2-7 complements and reinforces the conclusions reached from Table 2-6.

SUMMARY

Analyses of wind velocity data and comparison with wave forecast curves allow for the projection of the occurrence of certain wave heights on Belfast City Park Beach. The results of such analyses, shown in Tables 2-5 through 2-7, suggest that the wave regimen affecting the study area is one of predominately lower energy with waves generally two feet or less in height. More powerful waves with higher potential for erosion do, however, occur. Analyses of wind velocity data show that significant and/or design wave heights calculated for 10 year return periods and 1 - 2 hours duration for all onshore directions range from 4.1 feet to 0.9 feet (See Tables 2-5 and 2-7).

TIDES AND CURRENTS

The mean tide level for Belfast City Park Beack is 0.41 feet above the National Geodetic Vertical Datum (NGVD). The mean tidal range is 10.0 feet, and the mean spring range of tide is 11.5 feet.

Recorded annual maximum stillwater tide heights (tidal flooding) have been analyzed, and their frequency of occurrence has been established. Tidal flooding of 4.7 feet above MHW (10.1 NGVD) occurs every two years on the average. A tidal flood of approximately 2.6 feet above MHW (8.0 NGVD) occurs once a year on the average.

Data from observation of tidal gauge data and high water mark indicates that extra tropical storms (northeasters) pose the greatest threat of extremely severe tidal flooding. With the exception of these infrequent severe tidal flooding events, tidal action has a minimal effect on the configuration of Belfast City Park Beach.

TABLE 2-7

ANNUAL FREQUENCY AND PERCENT OCCURRENCE OF DESIGN WAVE BY DIRECTION AND WIND RETURN PERIOD

		Wind Return Periods											
		10 Year			5 Year			2 Year			1 Year		
Direction	Fetch (miles)	A[1]	H[2]	%[3]	A	H	%	A	H	%	A	H	%
N	0.9	<0.4	1.5	<0.5	<0.4	1.2	<0.5	<0.4	1.0	0.5	>0.4	0.6	>0.5
NNE	0.8	<0.6	1.5	<0.8	0.6	1.0	0.8	>0.6	0.9	>0.8	>0.6	0.7	>0.6
NE	1.1	<0.3	1.3	<0.4	<0.3	1.2	<0.4	0.3	1.0	0.4	>0.3	0.8	>0.4
ENE	3.1	<0.7	2.2	<1.0	0.7	2.0	1.0*	2.3	1.8	3.3	>7.4	0.5	>10.2
E	8.5	.05	4.0	0.1	0.5	3.5	0.8	2.2	2.4	3.0	30.4	1.3	42.1
ESE	6.6	0.5	3.0	0.6	0.7	2.5	0.9	0.9	2.0	1.2	>9.2	0.7	>12.7
SE	5.6	<.2	3.3	<.16	0.3	2.7	0.3	1.9	1.7	2.6	>5.6	0.6	>7.7

NOTES:

[1] A = Annual Frequency
[2] H = Design Wave Height in Feet
[3] % = Percent Occurrence
* Example: For 1.0 percent of time that onshore winds blow a two foot wave from the ENE will be produced; or the 5 year return design wave from the ENE will occur from 1.0% of time that onshore winds blow.

RATES OF EROSION

The lack of historical information concerning shoreline changes at Belfast City Park does not allow quantitative estimates of rates of erosion of the shoreline. There is sufficient evidence, however, to indicate that significant erosion of the beach is occurring. Field examination shows erosion of the till enbankment along the backshore and undercutting of a wooden staircase leading down the embankment. Communication with local residents reveals that waves have overtopped part of the backshore in times of storms. Some of the large boulders exposed at low tide in the near shore zone may be lag boulders originally part of the till composing the backshore and left behind as the shoreline retreated due to erosion and rising sea level.

EFFECT OF STRUCTURAL MODIFICATIONS

No structures at City Park Beach are of sufficient size to influence the shape and/or erosion patterns of the beach to any significant degree.

PROPOSED ALTERNATIVES

When viewed from the perspective of geologic time, the dominant trends in shoreline change that have been occurring for thousands of years will continue. The shoreline of Belfast City Park Beach will continue to retreat inland as sea level rises and erosion from winds and waves continually rework and reshape the configuration of the shoreline. Certain carefully considered shoreline modifications can, however, result in maximum benefits for the existing coastlines and can slow the rate at which natural changes occur in order to allow for longer term recreational use of the area. This section will discuss the impact of the prosposed alternatives on the study area. The impacts predicted are based upon the relationship between the given alternative and the shoreline processes discussed previously.

Plan 1 consists of beach widening, to a level berm of 50, 75 or 100 feet, by the direct placement of suitable sandfill along approximately 550 feet of shoreline of the study area. This plan initially would have a very positive effect on Belfast City Park Beach. An enlarged, safer, and aesthetically pleasing beach would be constructed with excellent potential for recreation. The coastal processes operations along the shoreline would in time, however, erode a substantial portion of the nourished sand. Even with the relatively low wind and wave regimen present, the storm waves which do occur would tend to move and redistribute the applied sand in a manner detrimental to the planned beach. For these reasons Plan 1 by itself does not meet the needs of the project.

Plan 2 consists of the above described nourishing and widening of the beach with the addition of the construction of two terminal groins at the northern and southern limits of the beach. Additionally there would be 20 feet of rock revetment placed both north of the northern groin structure and south of the southern structure. This plan has all the benefits of Plan 1 but with the needed protection given by the groins. The terminal structures would hold the sand at the beach rather than allowing longshore transport to move sediment away from the study area. The various analyses described in this appendix demonstrate the net longshore transport is towards the north (e.g. Figure 2-1, Tables 2-4 and 2-5). The northerly groin will serve to interupt this longshore transport and hold the sand in place. The rock revetment on the north side of this groin will stop the erosion which normally occurs on the "downdrift" side of a groin structure. Although the net longshore transport is to the north, 61% of all onshore winds are from directions that generate waves which would cause southerly longshore transport. The sourthern groin would serve to contain any sand which would otherwise move south. The added protection provided by the construction of the southern groin would ensure that the sand placed upon the beach during nourishment would remain for as long as possible. Plan 2 is therefore given the highest priority of the several plans proposed. It should best meet the goals of the project for the reasons stated above.

Plan 3 consists of the sandfill nourishment described above and the construction of a terminal groin structure at the northern limit of the beach. This plan, while meeting some of the goals of the project, does not provide for containment of any sand which might be transported in a southerly direction. It is therefore not recommended.

Plan 4 is similar to Plan 3 except that it provides for construction of a groin at the southern limit of the beach. Since the dominate direction of sediment transport is to the north, a groin at the southern end of the project would serve little purpose by itself. This plan is not recommended.

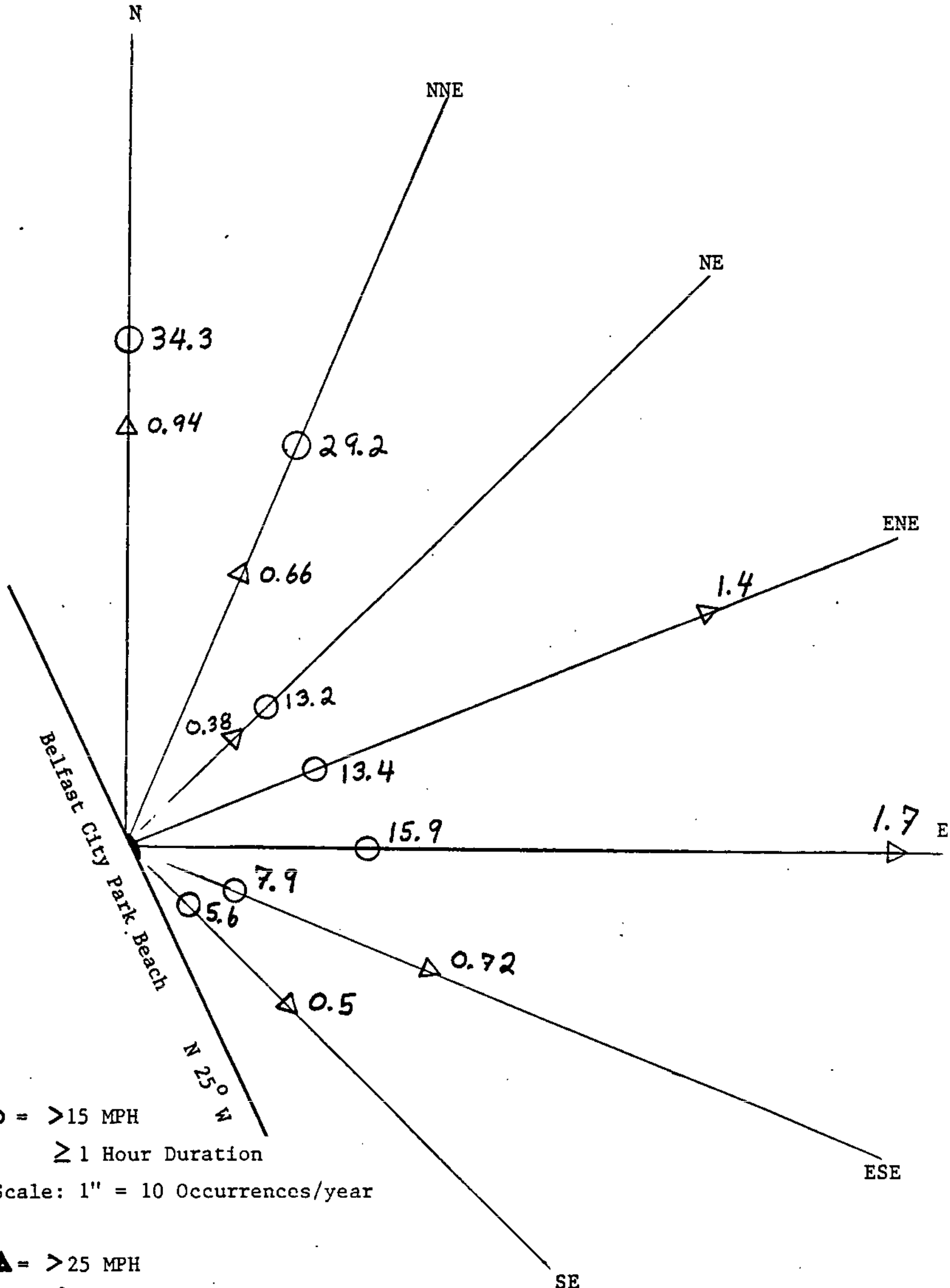
Plan 5 consists of the placement of rock revetment along the entire backshore area. This plan would eliminate much of the recreational and aesthetic benefits of Belfast City Park Beach. Plan 5 is therfore, not recommended.

Plan 6 consists of the construction of an offshore breakwater 1000 feet in front of the beach. The breakwater would cut down on the energy of incoming waves, and this would result in decreased beach erosion. Depending on its size, it may restrict circulation in the bay with resulting negative environmental and health impacts. The cost of such a breakwater would, in all likelihood, outweigh any benefits accruing from it and, therefore, is not considered a viable option for Belfast City Park.

Of all the alternatives described above, Plan 2, consisting of beach nourishment and the construction of a groin at the northern and southern limit of the project best meets the goals of the project and is the recommended plan.

FIGURE 2-1

ANNUAL FREQUENCY OF WINDS >15 MPH AND >25 MPH OF ≥1 HOUR DURATION

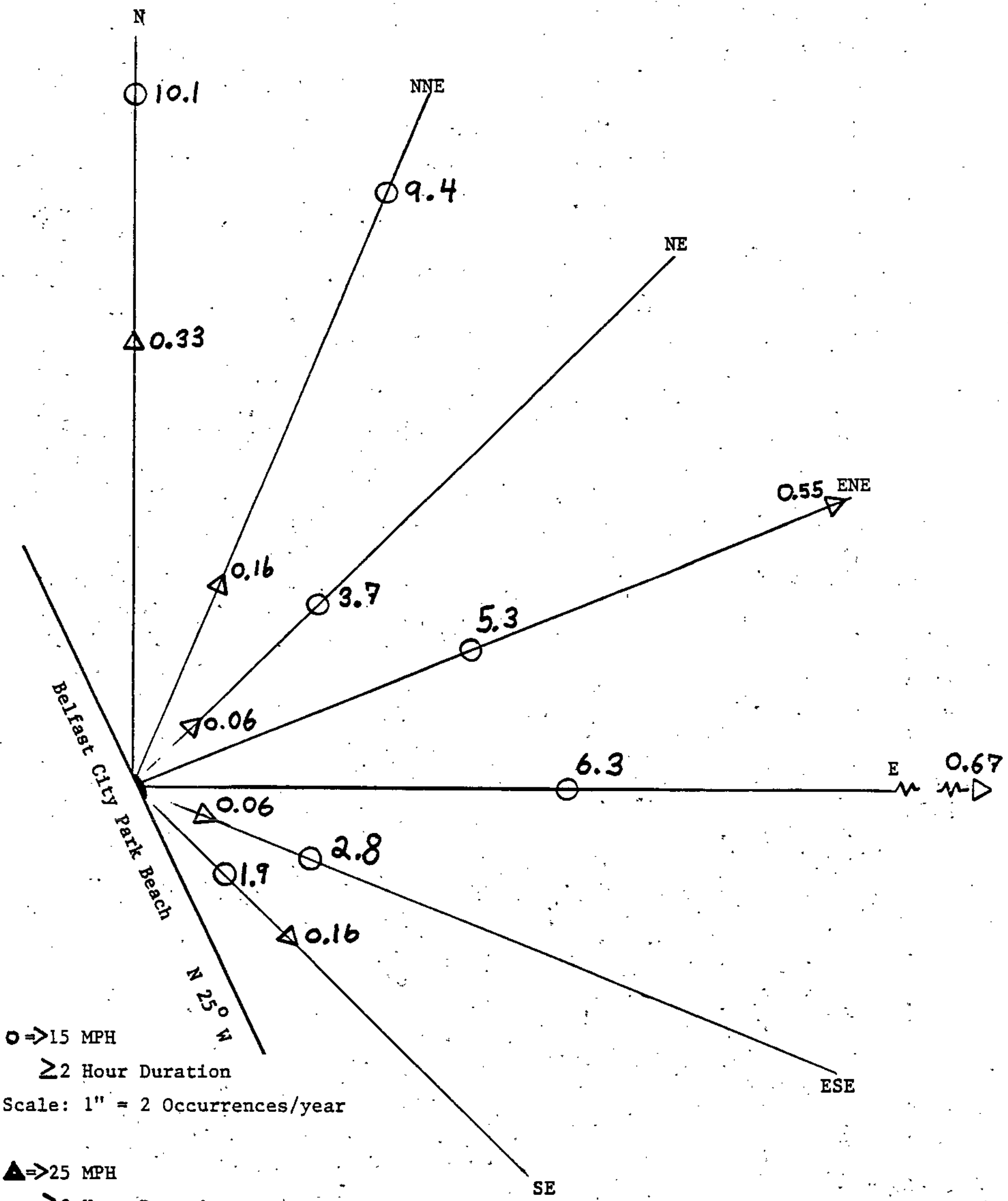


o = >15 MPH
≥1 Hour Duration
Scale: 1" = 10 Occurrences/year

▲= >25 MPH
≥1 Hour Duration
Scale: 1" = 0.33 Occurrences/year

FIGURE 2-2

ANNUAL FREQUENCY OF WINDS >15 MPH AND >25 MPH OF ≥2 HOURS DURATION



o => 15 MPH
≥2 Hour Duration
Scale: 1" = 2 Occurrences/year

▲ => 25 MPH
≥2 Hour Duration
Scale: 1" = 0.1 Occurrences/year

APPENDIX 3

TIDAL HYDROLOGY, ENGINEERING DESIGN, AND COST ESTIMATES

TIDAL HYDROLOGY, ENGINEERING DESIGN, AND COST ESTIMATES

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TIDAL HYDROLOGY, ENGINEERING DESIGN, AND COST ESTIMATES

This appendix will address in detail the design criteria used for Belfast City Park Beach. The criteria will apply to the design of those plans that have sufficient public use benefits to economically justify construction of the project. Tables 3-8a and 3-8b shows cost estimates of the considered plans of improvements including first cost, annual charges, and periodic nourishment are shown along with the detailed cost estimate of the selected plan of improvement.

TIDAL HYDROLOGY

This part of the appendix presents climatic and tidal hydrologic information necessary to evaluate erosion processes at Belfast City Park Beach and to design proper corrective measures. This section will also examine the factors causing water level variations and wave generation in the study area.

GENERAL

Wind generated waves are the principal agent of coastal erosion. Nearshore currents generated by waves, winds, astronomical tides or riverine flow also play an essential role. The precise location of most active erosion is determined to a significant extent by the water level as averaged over many tide cycles and wave periods. Substantial variations in water level can be produced by astronomical tides and by storm surges caused by the combination of high onshore winds and low atmospheric pressure.

ASTRONOMICAL TIDES

Tide Range. At Belfast, tides are semidiurnal, with two high and two low waters occurring during each lunar day (approximately 24 hours 50 minutes.) The resulting tide range is constantly varying in response to the relative positions of the earth, moon, and sun; the moon having the primary tide producing effect. Maximum tide ranges occur when the orbital cycles of these bodies are in phase. A complete sequence of tide ranges is approximately repeated over an interval of 19 years, which is known as a tidal epoch. The mean range of tide and the mean spring range of tide are 10.0 feet and 11.5 feet, respectively (see Figure 3-1). However, the maximum and minimum probable astronomic tide ranges have been estimated at about 15.4 and 5.0 feet, respectively, in studies by the Corps Coastal Engineering Research Center (CERC) (see Table 3-1). The variability of astronomical tide ranges is a significant factor in tidal flooding potential at Belfast. This is explained further in this appendix.

Tidal Datums. Because of the continual variation in water level due to the tides, several reference planes, called tidal datums, have been defined to serve as a reference zero for measuring elevations of both land

and water. Tidal datum information for Belfast is presented on Figure 3-1 and Table 3-1. These data were compiled using currently available short term National Ocean Survey (NOS) tidal benchmark data for Belfast along with the CERC report entitled "Tides and Tidal Datums in the United States", SR No. 7, 1981.

TABLE 3-1

BELFAST
TIDAL DATUM PLANES
(From 1941-1959 Tidal Epoch)

	Tidal Level (ft. NGVD)
Maximum Probable Astronomic High Water	8.1
Mean Spring High Water (MHWS)	6.2
Mean High Water (MHW)	5.4
Minimum Probable Astronomic High Water	2.9
Mean Tide Level (MTL)	0.4
National Geodetic Vertical Datum (NGVD)	0.0
Maximum Probable Astronomic Low Water	-2.1
Mean Low Water (MLW)	-4.6
Mean Spring Low Water (MLWS)	-5.3
Minimum Probable Astronomic Low Water	-7.3

Rising Sea Level. A phenomenon that has been observed through tide gaging and tidal benchmark measurements is that sea level is apparently rising with respect to the land along most of the U.S. coast. At Belfast the rise is estimated to be slightly less than 0.1 foot per decade. Sea level determination is generally revised at intervals of about 25 years to account for the changing sea level phenomenon. The NOS is presently engaged in the process of reducing tide data from the 1960-1978 tidal datum epoch to make such a revision.

STORM TYPES

Two distinct types of storms, distinguished primarily by their place of origin as being either extratropical or tropical cyclones, influence coastal processes in New England. These storms can produce above normal water levels and must be recognized in studying New England coastal problems.

Extratropical Cyclones. These are the most frequently occuring variety of cyclones in New England. Low pressure centers frequently form or intensify along the boundary between a cold dry continental air mass and a warm moist marine air mass just off the coast of Georgia or the Carolinas and move northeastward more or less parallel to the coast. These storms derive their energy from the temperature contrast between cold and warm air masses. The organized circulation pattern associated with this type of storm may extend for 1,000 to 1,500 miles from the storm center. The wind field in an extratropical cyclone is generally asymmetric with the highest winds in the northeastern quadrant. Since the storm center generally passes parallel and to the southeast of the New England coastline, highest onshore wind speeds are generally from the northeast. For this reason these storms are called "northeasters" or "nor'easters" by New Englanders. As the storm passes, local wind directions may vary from southeast to slightly west of north. Coastline exposed to these winds can experience high waves and extreme storm surge. Such storms cause the highest tide levels and most frequent tidal flooding along the northern New England coastline. The prime season for northeasters in New England is November through April.

Tropical Cyclones These storms form in a warm moist air mass over the Caribbean and the waters adjacent to the West Coast of Africa. The energy for the storm is provided by the latent heat of condensation. When the maximum wind speed in a tropical cyclone exceeds 75 mph, it is labeled a hurricane. Wind velocity at any position can be estimated based upon the distance from the storm center and the forward speed of the storm. The organized wind field may not extend more than 300 to 500 miles from the storm center. Recent hurricanes affecting New England generally have crossed Long Island Sound and proceeded landward in a generally northerly direction. However, hurricane tracks can be erratic. The storms lose much of their strength after landfall. For this reason the southern coast of New England experiences the greatest surge and wave action from the strong southerly to easterly flowing hurricane winds. However, on very rare occasions, reaches of coastline in northern New England may experience some storm surge and wave action from the weakened storm. The hurricane season in New England generally extends from August through October.

WINDS

An estimate of wind speed is one of the essential ingredients in any wave hindcasting effort. The most accurate estimate of winds at sea, which generate waves and propel them landward, is obtained by utilizing of barometric pressures recorded during a given storm. However, actual recorded wind speed and direction data observed at a land based coastal meteorological station can serve as a useful guide when more locally generated waves and currents are of interest. The disadvantage with using land based wind records is that they may not be totally indicative of wind velocities at the sea-air interface where the waves are generated. However, often they are the only available source of information and adjustments must be made to develop overwater estimates from the land based records.

The National Weather Service (NWS) recorded hourly observations of one-minute average wind speed and direction at Portland International Jetport in Portland, Maine from 1948 through 1965. Portland is the closest location to the project for which relatively complete, systematically recorded, wind data are available. These wind speed data were then adjusted to a standard 33-foot observation height and one-minute-average wind speeds were converted to one-hour average wind speeds. Since Portland International Jetport is not directly adjacent to the ocean, a land-to-sea conversion was applied. Because all fetches of interest at Belfast City Park Beach are less than 10 miles, an air-sea temperature difference adjustment was not applied. All adjustments were made in accordance with ETL 1110-2-305 on the subject of determining wave characteristics on sheltered waters. Utilizing these one-hour average wind data, the percent occurrence of wind direction and wind speed range has been computed. Since only onshore winds at Belfast City Park Beach are of interest, the wind directions utilized in this analysis have been limited to those between north (N) and southeast (SE). This analysis, the results of which are shown in Table 3-2, indicates that the principal onshore wind direction for wind speeds from 0 up to 25 mph is from the N and, for wind speed 25 mph or greater it is from the E. The maximum average wind speed (9.2 mph) is from the NNE and the greatest maximum speed was 49.2 mph from the ESE. Overall average speed is 8.4 mph. Table 3-2 also shows the resultant wind direction for various wind speed ranges. The resultant wind direction is a vector quantity computed using the product of wind speed and direction. It is an indicator of net air movement past a given location. Overall, the resultant wind direction is from the NE at the average resultant speed of 6.2 mph. The greatest percentage of wind speeds is shown to be in the 5 to 10 mph range.

Utilizing the above mentioned height adjusted data base, average wind speeds and resultant directions were computed over various durations with the other previously mentioned adjustments being made subsequently. Annual maximum values were then determined for each onshore direction. The frequency of these annual values has been determined using a Pearson Type III distribution function with expected probability adjustment. The systematic record alone was used for all analyses. In some cases, severe hurricane or northeast storm winds were identified as high outliers in a statistical test and sometimes high skews were observed. These cause some inconsistency in the estimates. All results are summarized in Tables 3-3(a) through 3-3(g). To obtain estimates of wind speed-duration relationships for a particular return period and direction, it is recommended that a graphical curve fitting analysis employing engineering judgement be conducted using the tabularized values. Figures 3-2 is an example of this technique based on data from Table 3-3(e).

Additionally, wind speed persistence was determined on a directional basis. The resulting wind speed persistence data, shown on Tables 3-4(a) through 3-4(g), for directions north through southeast, indicate the maximum number of consecutive hourly wind speed observations that occurred at or above a given speed from a particular direction. Data on Table 3-4(a) indicates an occurrence of winds in excess of 30 mph for five consecutive hours from an occurrence of winds from the north. Seven consecutive hourly values greater than 30 mph and three consective hourly values greater than 35 mph from the east are shown on Table 3-4(e). The highest average windspeeds, listed in Table 3-4(e) and 3-4(f), are 46 mph from the east and 49 mph fromt he east-southeast. Winds greater than 30 mph from the southeast for three consecutive hours are presented in Table 3-4(g). All this information demonstrates that high onshore winds can occur for extended periods of time in the study area. Similar to Tables 3-4(a) through 3-4(g), Tables 3-4(h) through 3-4(n) indicate percentages of occurrence on a directional basis for each speed class and duration. Wind speed persistence between N and SE, without regard to individual changes in onshore wind direction, is shown in Tables 3-4(o) and the associated percentages in Table 3-4(p). Resultant wind directions are listed in Table 3-4(q). Lower speed winds seems to come mainly from the northeast with an increasingly easterly trend as the speed class increases.

Waves generated during coastal storms are particularly potent as an erosive force. Therefore it is useful to examine wind conditions occurring during past storms when estimating the severity of wave conditions. Table 3-5 presents National Weather Service wind observations recorded at Portland during days of storm induced tidal flooding. It can be seen that the strongest winds recorded on these dates generally occurred between north and east. The highest speed listed, 69 mph from the east-northeast, was recorded on 31 August 1954.

STORM TIDES AND TIDE STAGE FREQUENCY

General. The total effect of astronomical tide combined with storm surge produced by wind, wave, and atmospheric pressure contributions is reflected in actual tide gage measurements. Since the astronomical tide is so variable at the study area, the time of occurrence of the storm surge greatly affects the magnitude of the resulting tidal flood level. Obviously, a storm surge of three feet occuring at a low astronomic tide would not produce as high a water level as would be produced if it occured at a higher tide. It is important to note that the storm surge itself varies with time thus introducing another variable into the makeup of the total flood tide at any point in time.

Summary of Extreme High Tides at Portland. A listing of selected annual maximum stillwater tide heights (measurements taken in protected areas in which waves are dampened out) for Portland is provided in Table 3-6. The Table also indicates the elevation that would be attained if the same tidal flood producing event were to occur at 1975 sea level. This listing was developed utilizing recorded tide gage data gathered at Portland by the NOS. Data in Table 3-6 shows that the five greatest tide levels occurred during northeasters, while only one listed event was a hurricane. The extratropical storm is clearly the prevalent type of storm affecting the study area and poses the greatest threat of severe tidal flooding.

Tidal Flood Frequency. A tide stage-frequency relationship for Portland, Maine has been developed utilizing a Pearson Type III distribution function using expected probability adjustment for analysis of adjusted

TABLE 3-2

PORTLAND, MAINE
ADJUSTED HOURLY WIND OBSERVATIONS BETWEEN N AND SE
(One-Hour Average Values)

PERCENT OF ONSHORE WIND SPEED AND DIRECTION OBSERVATIONS (X 10)

Direction	Wind Speed Range (MPH) 0-5	5-10	10-15	15-20	20-25	25-30	Over 30	All Inclusive	Avg. Speed (mph)	Max. Speed (mph)
N	62	143	88	25	6	1	1	326	8.2	36.9
NNE	27	67	58	21	5	1	0	179	9.2	34.8
NE	20	44	26	8	3	1	0	102	8.3	33.8
ENE	15	38	26	8	4	2	1	94	9.1	33.8
E	22	57	41	10	4	2	1	137	8.8	46.1
ESE	19	41	26	4	2	0	0	92	8.0	49.2
SE	21	30	15	3	1	0	0	70	7.2	37.9
N-SE	185	422	280	79	24	7	3	1,000	8.4	49.2
Resultant Direction:	NE	NE	NE	NE	NE	ENE	ENE	NE		

NOTES: 1) Wind speed ranges indicated include values greater than or equal to the lower limit and less than the higher limit.

2) Onshore winds occur 28 percent of the time. Therefore, average annual number of occurrences (A) = percent occurrence times 24.545. For instance, for a wind speed range of 0-5 mph from the north, A = 6.2 (24.545) = 152.

TABLE 3-3

FREQUENCY OF ADJUSTED ANNUAL MAXIMUM WIND SPEEDS (MPH)
PORTLAND, MAINE
(Based on 18 Years of Hourly Data Observations, 1948-1965)

(a)

Direction: N

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	20	31	37	41	47	51	55	0.9	N(0)
1	16	25	30	34	38	41	44	0.9	N(0)
2	14	23	27	30	33	36	38	0.6	N(0)
3	16	21	25	28	32	35	39	1.3	N(1)
4	14	21	25	28	31	34	37	1.1	N(1)
6	12	20	25	27	30	33	35	0.7	N(0)
8	13	19	23	26	30	33	36	1.3	N(1)
12	14	18	22	25	29	32	36	1.6	N(2)

(b)

Direction: NNE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	22	28	33	36	41	44	48	1.3	N(1)
1	18	23	27	30	33	36	39	1.3	N(1)
2	15	21	25	28	31	34	36	0.9	N(1)
3	12	22	25	27	30	31	32	0.1	N(0)
4	12	21	24	26	29	30	32	0.4	N(1)
6	12	20	23	25	27	29	30	0.3	N(0)
8	11	20	22	24	25	26	27	-0.3	N(0)
12	9	17	20	22	24	25	27	0.2	N(0)

Legend: H = Hurricane
N = Northeaster
(1) = Number of high outliers identified by high outlier test

(c)

Direction: NE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	17	28	34	37	41	45	48	0.7	N(0)
1	14	23	27	30	34	36	39	0.7	N(0)
2	10	21	25	27	29	31	33	0.1	N(0)
3	10	20	23	25	27	29	31	0.2	N(0)
4	9	18	23	25	28	30	32	0.4	N(0)
6	9	17	21	23	25	27	29	0.4	N(0)
8	8	16	19	21	24	26	28	0.5	N(0)
12	5	16	20	21	23	24	25	-0.2	N(0)

(d)

Direction: ENE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	13	33	39	41	44	46	47	-0.4	N(0)
1	11	27	31	33	36	37	38	-0.4	N(0)
2	10	25	30	31	34	35	36	-0.4	N(0)
3	10	24	29	31	33	34	36	-0.3	N(0)
4	10	23	27	29	31	33	34	-0.2	N(0)
6	10	21	26	28	31	33	35	0.2	N(0)
8	9	20	24	27	29	31	33	0.1	N(0)
12	6	18	22	25	27	29	31	-0.0	N(0)

(e)

Direction: E

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	21	36	44	49	56	61	67	0.8	H(1)
1	17	29	36	40	45	49	53	0.8	H(1)
2	14	26	33	38	43	47	51	0.8	H(0)
3	14	24	31	36	43	48	53	1.2	H(1)
4	12	23	29	32	37	40	43	0.6	N(1)
6	10	21	26	30	33	36	39	0.5	N(1)
8	12	21	27	31	36	40	44	1.0	N(1)
12	5	17	22	25	28	31	33	0.3	N(0)

(f)

Direction: ESE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	20	29	39	46	55	63	71	1.6	H(1)
1	16	24	31	37	45	51	57	1.6	H(1)
2	6	22	26	28	29	30	31	-0.7	N(0)
3	9	21	24	26	28	29	30	-0.4	N(0)
4	9	19	27	32	39	45	50	1.2	H(1)
6	8	18	24	28	33	36	40	0.9	H(1)
8	6	16	19	21	23	25	26	0.2	N(0)
12	4	15	20	23	26	28	30	0.4	H(0)

(g)

Direction: SE

Duration (hours)	Expected Return Period (Years) 1	2	5	10	25	50	100	Station Skew	Largest Systematic Event and High Outliers
1 min	10	29	38	44	50	55	60	0.6	H(0)
1	8	23	31	35	41	45	49	0.6	H(0)
2	8	22	30	35	41	45	50	0.8	H(0)
3	10	19	26	30	36	40	45	1.1	H(1)
4	7	18	24	28	33	37	41	0.8	N(1)
6	7	15	19	22	26	29	32	0.8	N(0)
8	6	17	23	28	33	38	42	1.0	N(1)
12	4	14	20	24	29	32	36	0.9	N(1)

TABLE 3-4(a)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : N

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
	NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)									
1	3727 (8)	1494 (12)	435 (17)	70 (22)	11 (29)	10 (32)	2 (37)	0 (0)	0 (0)	0 (0)
2	1161 (9)	375 (13)	106 (17)	18 (23)	2 (28)	1 (31)	0 (0)	0 (0)	0 (0)	0 (0)
3	471 (9)	160 (13)	34 (18)	8 (22)	1 (29)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
4	285 (10)	85 (14)	21 (19)	4 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	149 (9)	37 (14)	7 (18)	1 (21)	1 (29)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)
6	99 (10)	26 (14)	4 (20)	1 (23)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	56 (11)	16 (15)	4 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	42 (11)	17 (15)	1 (21)	0 (0)	1 (32)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	30 (11)	9 (15)	1 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	17 (12)	4 (19)	2 (24)	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	9 (9)	3 (15)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	4 (13)	4 (16)	0 (0)	0 (0)	1 (29)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	4 (10)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	6 (11)	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	2 (10)	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	3 (13)	2 (15)	1 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	4 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	3 (12)	1 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	2 (10)	0 (0)	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	1 (18)	2 (15)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	2 (9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	27	27	27	30	32	33	37	0	0	0
MAX DURATION:	27	27	27	20	12	5	1	0	0	0

TABLE 3-4(b)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : NNE

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	2396 (9)	924 (13)	357 (17)	78 (22)	9 (26)	1 (34)	0 (0)	0 (0)	0 (0)	0 (0)
2	724 (10)	276 (13)	91 (17)	11 (23)	2 (29)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3	288 (11)	143 (14)	31 (18)	10 (22)	0 (0)	1 (33)	0 (0)	0 (0)	0 (0)	0 (0)
4	132 (11)	58 (14)	13 (19)	5 (22)	1 (31)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	83 (11)	38 (14)	14 (18)	1 (23)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
6	40 (12)	19 (15)	4 (20)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	26 (13)	19 (14)	5 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	20 (13)	9 (16)	6 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	12 (15)	12 (15)	1 (25)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	14 (13)	10 (14)	2 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	6 (14)	5 (17)	2 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	6 (12)	3 (15)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	2 (16)	1 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	4 (14)	1 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	2 (14)	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	2 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	1 (16)	1 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	16	17	25	25	31	34	0	0	0	0
MAX DURATION:	20	20	11	9	4	3	0	0	0	0

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : NE

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	1757 (9)	597 (13)	172 (17)	40 (21)	6 (28)	2 (32)	0 (0)	0 (0)	0 (0)	0 (0)
2	433 (9)	140 (13)	35 (18)	6 (24)	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3	145 (10)	46 (14)	11 (19)	5 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
4	61 (11)	24 (15)	7 (19)	2 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	23 (11)	9 (14)	2 (19)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
6	11 (13)	6 (16)	6 (18)	1 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	7 (13)	4 (17)	2 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	8 (11)	2 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	0 (0)	0 (0)	1 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	2 (9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	1 (10)	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	1 (19)	1 (19)	1 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	1 (19)	1 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	1 (18)	1 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	19	19	22	25	30	32	0	0	0	0
MAX DURATION:	20	20	14	6	2	1	0	0	0	0

TABLE 3-4(c)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : ENE

MAXIMUM CONSECUTIVE HOURLY VALUES	NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH) WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	1423 (8)	519 (13)	145 (18)	55 (22)	16 (28)	7 (31)	0 (0)	0 (0)	0 (0)	0 (0)
2	394 (9)	119 (14)	33 (19)	9 (24)	5 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3	136 (10)	48 (15)	22 (18)	10 (23)	1 (29)	2 (32)	0 (0)	0 (0)	0 (0)	0 (0)
4	75 (12)	32 (16)	18 (20)	6 (25)	2 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	33 (13)	21 (17)	8 (20)	2 (23)	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
6	24 (13)	12 (17)	8 (21)	1 (30)	1 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	8 (15)	7 (16)	2 (18)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	7 (14)	5 (16)	1 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	4 (14)	2 (18)	0 (0)	1 (27)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	3 (17)	2 (22)	2 (24)	1 (26)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	2 (20)	1 (25)	2 (25)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	2 (20)	3 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	0 (0)	1 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	1 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	1 (10)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	20	25	25	30	30	32	0	0	0	0
MAX DURATION:	22	15	11	11	6	3	0	0	0	0

TABLE 3-4(d)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : E

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	1729 (8)	631 (12)	163 (17)	49 (22)	19 (28)	8 (33)	1 (37)	2 (44)	1 (46)	0 (0)
2	550 (9)	181 (14)	54 (19)	21 (24)	7 (30)	5 (35)	2 (42)	0 (0)	0 (0)	0 (0)
3	230 (10)	79 (14)	17 (19)	7 (22)	2 (29)	0 (0)	1 (37)	0 (0)	0 (0)	0 (0)
4	116 (10)	38 (14)	13 (18)	2 (25)	1 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	60 (12)	30 (16)	16 (19)	5 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
6	47 (12)	16 (16)	5 (22)	1 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	24 (12)	10 (17)	4 (22)	2 (24)	0 (0)	1 (37)	0 (0)	0 (0)	0 (0)	0 (0)
8	12 (12)	6 (18)	2 (24)	0 (0)	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	10 (16)	4 (22)	2 (26)	2 (26)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	4 (11)	2 (16)	0 (0)	1 (26)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	4 (18)	1 (25)	1 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	1 (14)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	0 (0)	0 (0)	0 (0)	0 (0)	1 (34)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	1 (9)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	2 (12)	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	0 (0)	0 (0)	0 (0)	1 (32)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	1 (16)	1 (16)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	26	26	27	32	34	37	42	44	46	0
MAX DURATION:	28	28	25	16	13	7	3	1	1	0

TABLE 3-4(e)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : ESE

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	1453 (8)	474 (12)	93 (18)	30 (24)	12 (30)	3 (38)	1 (49)	1 (49)	1 (49)	0 (0)
2	438 (9)	118 (14)	34 (18)	9 (23)	1 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
3	129 (10)	40 (13)	7 (18)	1 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
4	71 (10)	16 (14)	3 (19)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	24 (11)	10 (15)	4 (22)	2 (25)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
6	12 (12)	4 (14)	1 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	1 (15)	2 (16)	1 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	7 (13)	2 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	1 (12)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	1 (17)	1 (17)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	17	18	22	25	30	38	49	49	49	0
MAX DURATION:	10	10	7	5	2	1	1	1	1	0

TABLE 3-4(E)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : SE

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	1304 (8)	345 (12)	67 (17)	23 (23)	6 (29)	2 (34)	3 (37)	0 (0)	0 (0)	0 (0)
2	254 (9)	63 (14)	21 (19)	4 (28)	2 (33)	1 (36)	0 (0)	0 (0)	0 (0)	0 (0)
3	64 (11)	28 (16)	10 (20)	3 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
4	30 (11)	13 (15)	2 (20)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	10 (11)	2 (16)	0 (0)	0 (0)	0 (0)	1 (34)	0 (0)	0 (0)	0 (0)	0 (0)
6	3 (11)	0 (0)	0 (0)	1 (32)	1 (32)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	7 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
8	1 (29)	2 (22)	1 (29)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	1 (13)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	29	22	29	32	33	36	37	0	0	0
MAX DURATION:	9	8	8	6	6	5	1	0	0	0

TABLE 3-4(c)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : NNE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	15236	6754	2048	377	38	9	0	0	0	0
2	8913	4187	1128	180	18	4	0	0	0	0
3	5694	2999	694	142	7	7	0	0	0	0
4	3953	2057	521	81	9	0	0	0	0	0
5	2931	1617	427	34	0	0	0	0	0	0
6	2062	1199	270	27	0	0	0	0	0	0
7	1635	1022	252	16	0	0	0	0	0	0
8	1294	791	198	18	0	0	0	0	0	0
9	1011	708	101	20	0	0	0	0	0	0
10	854	517	90	0	0	0	0	0	0	0
11	568	296	49	0	0	0	0	0	0	0
12	458	189	0	0	0	0	0	0	0	0
13	321	117	0	0	0	0	0	0	0	0
14	283	94	0	0	0	0	0	0	0	0
15	168	67	0	0	0	0	0	0	0	0
16	108	36	0	0	0	0	0	0	0	0
17	38	38	0	0	0	0	0	0	0	0
18	40	40	0	0	0	0	0	0	0	0
19	43	43	0	0	0	0	0	0	0	0
20	45	45	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
MAX DURATION:	20	20	11	9	4	3	0	0	0	0

TABLE 3-4(1)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : N

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	26388	8987	2280	420	97	38	4	0	0	0
2	16379	5117	1195	243	67	13	0	0	0	0
3	11017	3443	728	162	54	7	0	0	0	0
4	8167	2480	512	117	54	9	0	0	0	0
5	5851	1718	359	90	45	11	0	0	0	0
6	4447	1402	270	67	40	0	0	0	0	0
7	3412	1116	236	47	31	0	0	0	0	0
8	2677	934	180	54	36	0	0	0	0	0
9	2022	667	162	61	20	0	0	0	0	0
10	1482	494	135	67	22	0	0	0	0	0
11	1137	395	99	25	25	0	0	0	0	0
12	916	350	108	27	27	0	0	0	0	0
13	876	263	117	29	0	0	0	0	0	0
14	786	220	94	31	0	0	0	0	0	0
15	640	202	101	34	0	0	0	0	0	0
16	611	216	72	36	0	0	0	0	0	0
17	535	153	38	38	0	0	0	0	0	0
18	404	162	40	40	0	0	0	0	0	0
19	299	128	43	43	0	0	0	0	0	0
20	314	135	45	45	0	0	0	0	0	0
21	236	142	47	0	0	0	0	0	0	0
22	198	49	49	0	0	0	0	0	0	0
23	155	52	52	0	0	0	0	0	0	0
24	54	54	54	0	0	0	0	0	0	0
MAX DURATION:	27	27	27	20	12	5	1	0	0	0

TABLE 3-4(h)

TABLE 3-4(J)

WIND SPEED PERSISTENCE SITE LOCATION : PORTLAND ADJUSTED DATE : 480101 TO 651231 DIRECTION : NE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	8257	2886	892	193	18	4	0	0	0	0
2	3913	1411	467	90	4	0	0	0	0	0
3	2055	795	310	67	0	0	0	0	0	0
4	1213	521	216	36	0	0	0	0	0	0
5	719	337	168	22	0	0	0	0	0	0
6	485	256	162	13	0	0	0	0	0	0
7	377	189	94	0	0	0	0	0	0	0
8	270	108	54	0	0	0	0	0	0	0
9	142	81	61	0	0	0	0	0	0	0
10	157	90	45	0	0	0	0	0	0	0
11	99	74	49	0	0	0	0	0	0	0
12	81	81	27	0	0	0	0	0	0	0
13	88	88	29	0	0	0	0	0	0	0
14	94	94	31	0	0	0	0	0	0	0
15	67	67	0	0	0	0	0	0	0	0
16	36	36	0	0	0	0	0	0	0	0
17	38	38	0	0	0	0	0	0	0	0
18	40	40	0	0	0	0	0	0	0	0
19	43	43	0	0	0	0	0	0	0	0
20	45	45	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
MAX DURATION:	20	20	14	6	2	1	0	0	0	0

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : ENE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	7873	3133	1125	400	108	29	0	0	0	0
2	4263	1788	723	247	67	9	0	0	0	0
3	2513	1220	553	209	40	13	0	0	0	0
4	1707	934	413	144	36	0	0	0	0	0
5	1112	696	303	101	22	0	0	0	0	0
6	795	499	202	67	13	0	0	0	0	0
7	519	346	110	63	0	0	0	0	0	0
8	413	252	90	54	0	0	0	0	0	0
9	303	182	81	61	0	0	0	0	0	0
10	247	157	90	45	0	0	0	0	0	0
11	198	124	49	25	0	0	0	0	0	0
12	135	108	0	0	0	0	0	0	0	0
13	88	29	0	0	0	0	0	0	0	0
14	94	31	0	0	0	0	0	0	0	0
15	67	34	0	0	0	0	0	0	0	0
16	72	0	0	0	0	0	0	0	0	0
17	76	0	0	0	0	0	0	0	0	0
18	40	0	0	0	0	0	0	0	0	0
19	43	0	0	0	0	0	0	0	0	0
20	45	0	0	0	0	0	0	0	0	0
21	47	0	0	0	0	0	0	0	0	0
22	49	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
MAX DURATION:	22	15	11	11	6	3	0	0	0	0

TABLE 3-4(k)

WIND SPEED PERSISTENCE SITE LOCATION : PORTLAND ADJUSTED DATE : 480101 TO 651231 DIRECTION : E

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	11459	4211	1307	469	144	56	18	4	2	0
2	6842	2511	849	323	94	36	13	0	0	0
3	4441	1698	573	229	61	13	7	0	0	0
4	2965	1204	485	180	54	9	0	0	0	0
5	2100	932	404	168	34	11	0	0	0	0
6	1563	647	243	108	40	13	0	0	0	0
7	1053	487	189	110	31	16	0	0	0	0
8	701	341	144	90	36	0	0	0	0	0
9	546	263	101	81	20	0	0	0	0	0
10	337	157	67	45	22	0	0	0	0	0
11	272	124	74	25	25	0	0	0	0	0
12	189	108	54	27	27	0	0	0	0	0
13	175	117	29	29	29	0	0	0	0	0
14	189	126	31	31	0	0	0	0	0	0
15	135	101	34	34	0	0	0	0	0	0
16	72	72	36	36	0	0	0	0	0	0
17	76	76	38	0	0	0	0	0	0	0
18	81	81	40	0	0	0	0	0	0	0
19	85	85	43	0	0	0	0	0	0	0
20	45	45	45	0	0	0	0	0	0	0
21	47	47	47	0	0	0	0	0	0	0
22	49	49	49	0	0	0	0	0	0	0
23	52	52	52	0	0	0	0	0	0	0
24	54	54	54	0	0	0	0	0	0	0
MAX DURATION:	28	28	25	16	13	7	3	1	1	0

TABLE 3-4(1)

WIND SPEED PERSISTENCE	SITE LOCATION : PORTLAND ADJUSTED	DATE : 480101 TO 651231	DIRECTION : ESE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	7354	2264	510	137	31	7	2	2	2	0
2	3742	1083	274	63	4	0	0	0	0	0
3	1819	373	121	20	0	0	0	0	0	0
4	1132	341	81	18	0	0	0	0	0	0
5	528	225	67	22	0	0	0	0	0	0
6	298	121	27	0	0	0	0	0	0	0
7	157	79	16	0	0	0	0	0	0	0
8	162	54	0	0	0	0	0	0	0	0
9	40	20	0	0	0	0	0	0	0	0
10	22	22	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
MAX DURATION:	10	10	7	5	2	1	1	1	1	0

TABLE 3-4(m)

TABLE 3-4(n)

WIND SPEED PERSISTENCE SITE LOCATION : PORTLAND ADJUSTED DATE : 480101 TO 651231 DIRECTION : SE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	4962	1422	348	103	36	20	7	0	0	0
2	1864	580	175	45	22	13	0	0	0	0
3	775	317	94	34	13	7	0	0	0	0
4	422	171	36	9	9	9	0	0	0	0
5	168	45	11	11	11	11	0	0	0	0
6	67	27	13	13	13	0	0	0	0	0
7	31	31	16	0	0	0	0	0	0	0
8	36	36	18	0	0	0	0	0	0	0
9	20	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
MAX DURATION:	9	8	8	6	6	5	1	0	0	0

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : N -SE

NUMBER OF OCCURENCES AND (AVERAGE WIND SPEEDS, MPH)

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	3918 (8)	2337 (12)	822 (16)	225 (21)	53 (28)	26 (32)	6 (37)	1 (41)	0 (0)	0 (0)
2	1388 (8)	700 (12)	255 (17)	48 (23)	17 (29)	6 (33)	1 (40)	1 (48)	1 (48)	0 (0)
3	653 (8)	333 (12)	96 (17)	34 (23)	8 (29)	6 (35)	2 (41)	0 (0)	0 (0)	0 (0)
4	422 (8)	192 (13)	54 (18)	14 (23)	4 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
5	286 (8)	107 (13)	49 (18)	14 (23)	3 (32)	2 (33)	0 (0)	0 (0)	0 (0)	0 (0)
6	239 (8)	95 (13)	23 (18)	9 (25)	3 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
7	180 (8)	68 (13)	13 (19)	8 (24)	0 (0)	1 (37)	0 (0)	0 (0)	0 (0)	0 (0)
8	164 (9)	48 (14)	16 (19)	4 (25)	2 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
9	108 (9)	45 (14)	16 (21)	2 (26)	1 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
10	101 (9)	31 (15)	16 (18)	1 (26)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
11	73 (10)	38 (14)	8 (19)	2 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
12	66 (9)	32 (15)	4 (18)	1 (26)	1 (29)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
13	54 (10)	31 (15)	9 (20)	2 (24)	1 (34)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
14	66 (10)	15 (16)	2 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
15	52 (11)	19 (14)	3 (21)	2 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
16	43 (10)	13 (14)	4 (20)	2 (30)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
17	44 (10)	9 (16)	3 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
18	31 (10)	8 (15)	4 (20)	1 (27)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
19	28 (10)	8 (16)	2 (22)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
20	32 (11)	4 (17)	3 (22)	1 (24)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
21	32 (11)	4 (14)	3 (22)	1 (28)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
22	25 (11)	6 (16)	2 (21)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
23	22 (10)	12 (16)	1 (23)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
24	20 (10)	5 (18)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
MAX AVG SPEED:	15	19	24	30	34	37	41	48	48	0
MAX DURATION:	48	48	48	35	13	7	3	2	2	0

TABLE 3-4(d)

TABLE 3-4(p)

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : N -SE

PERCENTAGE OF ONSHORE WIND OBSERVATIONS (X1000)

CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	79378	29325	8504	2100	472	164	31	7	4	0
2	66921	22524	6190	1447	323	85	13	4	4	0
3	58900	19016	4899	1220	243	67	13	0	0	0
4	53674	16415	4268	970	198	27	0	0	0	0
5	49078	14521	3765	887	146	34	0	0	0	0
6	45767	13382	3167	728	135	13	0	0	0	0
7	42295	11965	2830	629	79	16	0	0	0	0
8	39586	10979	2749	503	90	0	0	0	0	0
9	36408	10290	2507	425	61	0	0	0	0	0
10	34119	9366	2246	404	45	0	0	0	0	0
11	32120	9117	1828	371	49	0	0	0	0	0
12	30619	8248	1671	323	34	0	0	0	0	0
13	28411	7504	1606	321	29	0	0	0	0	0
14	27830	6604	1384	283	0	0	0	0	0	0
15	26280	6085	1381	303	0	0	0	0	0	0
16	24546	5642	1294	252	0	0	0	0	0	0
17	22147	5155	1146	191	0	0	0	0	0	0
18	20943	4933	1092	162	0	0	0	0	0	0
19	20357	4737	982	128	0	0	0	0	0	0
20	19901	4492	943	135	0	0	0	0	0	0
21	18962	4434	802	94	0	0	0	0	0	0
22	17888	4200	692	49	0	0	0	0	0	0
23	16841	4081	568	52	0	0	0	0	0	0
24	15795	3504	539	54	0	0	0	0	0	0
MAX DURATION:	48	48	48	35	13	7	3	2	2	0

WIND SPEED PERSISTENCE   SITE LOCATION : PORTLAND ADJUSTED   DATE : 480101 TO 651231   DIRECTION : N -SE

RESULTANT WIND DIRECTIONS

MAXIMUM CONSECUTIVE HOURLY VALUES	WIND SPEED CLASS, MPH >5	>10	>15	>20	>25	>30	>35	>40	>45	>50
1	NNE	NE	NNE	NE	ENE	NE	E	E	CAL	CAL
2	NE	NE	NE	NE	ENE	ENE	E	ESE	ESE	CAL
3	NE	NE	NE	ENE	ENE	ENE	E	CAL	CAL	CAL
4	NE	NE	ENE	ENE	ENE	CAL	CAL	CAL	CAL	CAL
5	NE	ENE	NE	NE	ENE	ENE	CAL	CAL	CAL	CAL
6	NE	NE	NE	ENE	E	CAL	CAL	CAL	CAL	CAL
7	NE	ENE	ENE	ENE	CAL	E	CAL	CAL	CAL	CAL
8	NE	ENE	NE	NE	NNE	CAL	CAL	CAL	CAL	CAL
9	ENE	NE	E	NE	E	CAL	CAL	CAL	CAL	CAL
10	NE	NE	NE	ENE	CAL	CAL	CAL	CAL	CAL	CAL
11	NE	NE	NE	E	CAL	CAL	CAL	CAL	CAL	CAL
12	ENE	NE	NNE	ENE	N	CAL	CAL	CAL	CAL	CAL
13	ENE	NE	NE	ENE	E	CAL	CAL	CAL	CAL	CAL
14	NE	NE	NNE	CAL	CAL	CAL	CAL	CAL	CAL	CAL
15	NE	NE	NNE	ENE	CAL	CAL	CAL	CAL	CAL	CAL
16	NE	NE	NE	E	CAL	CAL	CAL	CAL	CAL	CAL
17	NE	NE	NNE	CAL	CAL	CAL	CAL	CAL	CAL	CAL
18	NE	NNE	ENE	NNE	CAL	CAL	CAL	CAL	CAL	CAL
19	NE	NE	NE	CAL	CAL	CAL	CAL	CAL	CAL	CAL
20	NE	NNE	NE	E	CAL	CAL	CAL	CAL	CAL	CAL
21	NE	ENE	ENE	N	CAL	CAL	CAL	CAL	CAL	CAL
22	ENE	ENE	NNE	CAL	CAL	CAL	CAL	CAL	CAL	CAL
23	NE	NE	ENE	CAL	CAL	CAL	CAL	CAL	CAL	CAL
24	NE	NNE	CAL	CAL	CAL	CAL	CAL	CAL	CAL	CAL

TABLE 3-4(q)

TABLE 3-5

PORTLAND INTERNATIONAL JETPORT
NATIONAL WEATHER SERVICE
WIND OBSERVATIONS
DAYS OF MAXIMUM TIDAL FLOODS

Date	Resultant Direction	Resultant Speed (MPH)	Average Speed (MPH)	Fastest Mile Speed (MPH)	Fastest Mile Direction
7 Feb 78	NNE	21.4	22.0	29	NE
9 Jan 78	S	22.7	29.2	48	SE
16 Mar 76	NE	10.2	12.2	23	NE
30 Nov 44**					
20 Nov 45**					
6 Apr 58***	E*	--	13.8	38	NE
28 Dec 59***	NNE*	--	13.1	24	NE
19 Feb 72	NE	16.9	19.0	34	E
4 Mar 31**					
21 Apr 40**					
20 Jan 61	N*	--	22.2	35	N
5 Apr 77***	E	5.8	12.9	25	SE
2 Nov 63	N*	--	11.4	20	WSW
20 Nov 72	NNW	2.9	10.9	22	NE
4 Apr 73	ENE	7.4	9.9	25	SE
21 Dec 76	WNW	10.0	11.2	21	W
19 Nov 18**					
7 Dec 19**					
31 Aug 54	ENE*	--	23.6	69	E
21 Dec 60	SE*	--	15.0	40	SE
16 Apr 61	ENE*	--	17.5	31	NE
23 Dec 68	SSE	3.0	8.3	21	SE
14 Apr 72	N	10.3	11.5	17	NE
11 Dec 50	NNE*	--	8.4	21	NE
13 Apr 53	NNE*	--	13.7	27	N
25 Oct 53	NNE*	--	19.3	35	NE
11 Dec 69	S	11.2	18.0	31	S
17 Mar 72***	SE	6.3	7.9	24	SE
2 Dec 74	NNE	12.4	13.4	23	NE

*Resultant speed and direction not available for the period prior to 1964 therefore direction shown is prevailing wind direction.

**Wind data not available.

***Day prior to maximum tidal flood is shown as it is more indicative of storm conditions.

TABLE 3-6

SELECTED ANNUAL MAXIMUM STILLWATER TIDE HEIGHTS
PORTLAND, MAINE
(1912-1978)

Date	Observed Elevation (ft. NGVD)	Adjusted* Elevation (ft. NGVD)	Recurrence** Interval (Years)
7 Feb 1978	9.6	9.6	100
9 Jan 1978	9.4	9.4	63
16 Mar 1976	8.8	8.8	15
30 Nov 1944	8.7	8.9	18
20 Nov 1945	8.7	8.9	18
7 Apr 1958	8.5	8.6	10
29 Dec 1959	8.5	8.6	10
19 Feb 1972	8.5	8.5	8
4 Mar 1931	8.4	8.8	15
21 Apr 1940	8.2	8.5	8
20 Jan 1961	8.2	8.3	5
6 Apr 1977	8.2	8.2	4
2 Nov 1963	8.1	8.2	4
20 Nov 1972	8.1	8.1	3
4 Apr 1973	8.1	8.1	3
21 Dec 1976	8.1	8.1	3
19 Nov 1918	8.0	8.5	8
7 Dec 1919	8.0	8.5	8
31 Aug 1954***	7.9	8.1	3
21 Dec 1960	7.9	8.0	3
16 Apr 1961	7.9	8.0	3
23 Dec 1968	7.9	8.0	3
14 Apr 1972	7.9	7.9	3
11 Dec 1950	7.8	8.0	3
13 Apr 1953	7.8	8.0	3
25 Oct 1953	7.8	8.0	3
11 Dec 1969	7.8	7.9	3
18 Mar 1972	7.8	7.8	2
2 Dec 1974	7.8	7.8	2

*Observed values after adjustment for rising sea level; adjustment made to 1975 sea level conditions based on NOS publication "Trends and Variability of Yearly Mean Sea Level, 1893-1972."

**Recurrence interval of adjusted tide elevations using expected probability adjustment.

***Hurricane Carol

annual maximum stillwater tide levels. Utilizing high watermark data from Belfast, a stage correlation with Portland was developed. Using this correlation and the Portland frequency curve, a tidal flood frequency relationship for Belfast City Park Beach was estimated (Figure 3-3).

Tidal Flood Profiles. Profiles of major past tidal floods have been developed along the New England coast. NOS tide gage records and high watermark data gathered between gage locations after major storms have been utilized in the development of these profiles. Additionally, profiles of storm tides of selected frequencies have been developed utilizing frequency distributions at tide gages and high watermark information. Location maps and profiles for Belfast City Park are shown on Plates 3-1 and 3-2.

CONSIDERED PLANS

A range of plans were evaluated for solutions to the erosion problems at Belfast City Park Beach. The sandfill alternative plans listed below all consider 50, 75, or 100 foot berms, a beach length of 550 feet, and have a backshore elevation of 15.0 feet above mean low water (10.4 feet NGVD). There will also be 20 feet of rock revetment north of the northern groin structure and 20 feet south of the southern groin structure (revetment only where a structure is being placed) to prevent scouring and erosion of the adjacent embankments.

PLAN 1 - sandfill only along approximately 550 feet of beach.

PLAN 2 - sandfill and construction of two terminal groin structures at the northern and southern limits of the beach

PLAN 3 - sandfill and construction of a terminal groin structure at the northern limit of the study area.

PLAN 4 - sandfill and construction of a terminal groin structure at the southern limit of the study area.

PLAN 5 - rock revetment along the 780 foot backshore area.

PLAN 6 - construction of an offshore breakwater approximately 1000 feet in front of the 780 foot beach.

The rock revetment provides protection to the backshore park and does not contribute to the recreational area of the beach, therefore few benefits are attained from this plan. Therefore, this plan was not considered further in the planning process.

The offshore breakwater will slow down the rate of erosion but the cost greatly outweighs the benefits and also was not considered further in our study.

The littoral drift in the western end of Belfast Bay is in a northerly and southerly direction with the net drift to the north. Plans 3 and 4 will only partially hold the sandfill in place, but the nourishment rate will be high. Plan 1 will have a higher nourishment rate than Plans 3 and 4, and would not hold the sandfill stable for a prolonged period of time.

Plan 2 would compartmentize the sandfill and not expose the sandfill to the anticipated wave action as in Plans 1,3, and 4. Plan 2 would cause the least detrimental impact on adjacent shorelines, and is a viable solution for solving the erosion problems at the beach.

DESIGN STILLWATER LEVEL

The stillwater level elevation selected for Belfast City Park Beach is 14.0 feet above mean high water (9.4 feet NGVD). This stillwater level is 4.0 feet above mean high water and is estimated to occur with a frequency of once in twelve years. This was selected as the maximum stillwater level that should be considered based on the backshore elevation, the design wave, and wave runup.

DESIGN WAVE

The design wave that can occur at Belfast City Park Beach has been determined to be a 5.0 foot high breaking wave with a wave period of 3.7 seconds. The wave height was used for the design of the sandfill and groin structures. The design wave was determined by the application using ETL 1110-2-305 and the coastal engineering technical notebook (CETN) for windspeeds, wave heights, fetch distances and wave periods. Table 3-7 gives a summary of pertinent data used in the selection of the design wave. The beach is exposed from wave attack from the north to southeast directions. The depths shown in Table 3-7 are average depths for their respective directions. The design wave of 5.0 feet is based on a wind velocity of 38 mph for 110 minutes, a fetch distance of 8.5 miles, an average water depth of 50 feet and the direction is from the east.

TABLE 3-7
WAVE INFORMATION AT BELFAST CITY PARK BEACH

Distance	N	NNE	NE	ENE	E	ESE	SE
Fetch Distance (F in miles)	0.9	0.8	1.1	3.1	8.5	6.6	5.6
Average Water Depth (d in feet)	20'	20'	20'	30'	50'	50'	50'
Wind Velocity (V in mph)	34	30	30	33	40	37	35
Duration (t in minutes)	60	60	60	60	60	60	120
Significant Wave Height (Hs in feet)	1.3	1.0	1.2	2.1	4.1	3.3	3.0
Significant Wave Period (Tin seconds)	1.75	1.70	1.75	2.6	3.7	3.4	3.3

GROIN DESIGN

DESIGN PARAMETERS

The design of the terminal groin structure was based on the following criteria:

1. Stillwater elevation of 140 feet above mean low water (9.4 feet NGVD).
2. Side slopes of 1 vertical on 2 horizontal.
3. Head slope of 1 vertical on 2 horizontal.
4. 5.0 foot breaking wave (entire structure).
5. KD coefficient of 2.0.
6. Stone unit weight of 165 pcf.

WEIGHT OF STONES

The minimum weight of armor stone was determined from the following formula:

$$W = \frac{WrH^3}{KD(Sr-1)^3 \ Cot\ \emptyset}$$

where:

W = the weight of the armor stone, in pounds.

Wr = the unit weight of stone, in p.c.f.

KD = a dimensionless, experimental coefficient.

H = the design wave height, in feet.

Sr = the specific gravity of the armor stone relative to Seawater = $\frac{(Wr)}{(Ww)}$

Ww = the unit weight of seawater, 64 p.c.f.

Ø = the angle of the structure's side slopes measured from the horizontal, in degrees.

The groin design is based on the use of a single layer armor unit placed upon a well graded core and bedding layer. Changes from the suggested Shore Protection Manual (SPM) criteria (KD factor, layer thickness, core-stone weight) were made to accommodate site specific conditions, namely a small groin, both in length and height, and to insure adequate stability through proper gradation from armor to bedding stone. For a nonbreaking wave condition and single armor layer, KD=2.3 is recommended by the SPM. However, this value has been reduced to KD=2.0 to account for the breaking wave condition; this is a conservative value for the KD coefficient, compensating for the single layer armor unit. The armor stone for the groin is based on a 5.0 foot breaking wave, a 1 on 2 side slope, stone unit weight of 165 lbs/cf and KD=2.0. This results in a stone weighing approximately 1,300 pounds. The armor layer will consist of stones 75% to 125% of the determined weight: 1000 to 1600 pounds. Based on the assumptions that stones are cubical in shape, the average armor stone would measure 2.3 feet on a side. Thus, the armor layer will be a maximum of 2.5 feet thick. Since a single layer armor unit was selected, the underlayer stone was increased to one-fourth the armor stone instead of one-tenth. The core stone weight was determined to 325 pounds. The core-bedding layer will be composed of stones weighing between 200 and 400 pounds or more (75% to 125% of $\frac{W}{4}$). The minimum thickness of this underlayer is 1.5 feet of cover. Typical cross sections showing side slopes, stone size, and layer thicknesses are shown on plate 3-7.

GROIN CREST WIDTH, LENGTH, AND ELEVATION

The top width of the groin structure will be designed at 8.0 feet uniformly from head to trunk. To stablize the groin structure, and prevent uplift, the vertical shore section of the groin should have a minimum elevation of 5.0 feet; a minimum height of 5.0 feet should also be observed at the head of the structure to prevent scouring and assure stability. The groin should extend landward to intersect the existing embankment, and have a length equal to the anticipated berm width of the artifically placed sandfill. The top elevation of the groin is 16.0 feet above mean low water and is 1.0 foot above the proposed sandfill. The intermediate sloped section will have the same steepness and slope as the proposed sandfill (1 vertical on 15 horizontal). This slope will continue until the 5 foot minimum elevation is reached, where at this point the groin will slope down at a 1.0 on 2.0 (vertical:horizontal).

CONSTRUCTABILITY

The proposed groin structure is designed based on a storm that would occur approximately once every 12 years. The groin structure, as previously stated, was designed with a uniform crest width of 8.0 feet and will have one typical cross section from head to trunk. This provides for easier construction for this small structure by minimizing the different weight classifications of stone and at the same time provide a larger factor of safety for the structure.

WAVE RUNUP ON BEACH

Wave runup depends on the water depth at the sandfill toe, the bottom slope in front of the sandfill and the wave height at the toe. The wave runup for Belfast City Park Beach is based on a design stillwater elevation of 14.0 feet above mean low water (9.4 feet NGVD). The design slope of 1 vertical 15 horizontal was used for the beach face based on recent surveys which showed this as the natural slope that exists on the beach. Using this criteria long with a 5.0 foot breaking wave, the wave runup would exceed the beach berm elevation of 15.0 feet MLW (10.4 feet NGVD) by 0.68 feet. This minor overtopping could cause some redistribution of sandfill but no serious erosion is expected to occur as a result.

SANDFILL

Design of the sandfill was based on the criteria in the 1977 "Shore Protection Manual" and on the existing sand on the beach. The criteria in the Shore Protection Manual was established to be used as a guide in the design and construction of the beaches. The selection of the sandfill is also dependent on the availability of material from offshore or a nearby land source. The sandfill criteria designed for Belfast City Park Beach is as follows

Percent Passing by Weight	U.S. Standard Sieve
100%	3/8"
85 - 100%	# 4
30 - 60%	# 20
5 - 30%	# 50
0 - 10%	#100
0%	#200

The average particle specific gravity of the sandfill shall be not less than 2.60, have a median grain size between 0.65 and 1.50 millimeter, have a sorting coefficient greater than 1.6 and less than 2.0, not more than 15% mica or other flakes, or 5% friable particles will be excepted.

There are several suitable commercial land-based sand sources in the vicinity of Belfast City Park Beach. An offshore sand source was considered but it is not suitable for beachfill because it does not meet the above criteria. Therefore, this offshore sand source was not considered to be viable.

The existing sandfill throughout the beach has an average median diameter of approximately 4.0 millimeters and a sorting coefficient of 2.43. (See Figures 3-4 to 3-12). The selected mentioned gradation of sand is within the accepted criteria as set forth in the 1977 "Shore Protection Manual" for medium beach sand which is satisfactory to stabilize the beach and is well suited for beach bathing purposes. Preliminary sampling of the nearby land source pits indicates that the desired material for Belfast City Park Beach are available.

The proposed sandfill is designed with a slope of 1 vertical on 15 horizontal. This slope is very similar to the existing slope and it is the same as the other stable beaches in the area. The proposed beachfill with a better quality will minimize the impact on the area near Belfast Bay. It is expected that this coarser grade of sandfill will reduce littoral movement that would normally take place. Preliminary estimates from commercial land-based sand sources indicate that the sandfill price is approximately $8 per cubic yard delivered to the beach.

The horizontal level beach berm is 15.0 feet above mean low water (10.4 feet NGVD). This elevation was chosen from the criteria on design wave, beach berm slope, wave runup and the existing condition of the backshore area.

During construction, a bulldozer and natural occurring wave action will distribute the fill material as it is placed in the interidal zone. The sandfill quantities were calculated based on the difference between the 1983 and 1984 surveys, shoreline change maps and historic photos.

Also the estimated cost includes a contingency factor to allow for unexpected overruns. Every precaution will be taken to assure that the contractor places the specified quality of sand on the beach This will be accomplished by frequent sampling and testing of the material during construction. This in turn will ensure the quality of the beachfill thereby reducing the impact of finer material on the offshore area. The sandfill should be placed during the period of 1 April through 30 June to insure stability of the new beach.

PERIODIC NOURISHMENT

Throughout the report, nourishment is referred to as annual periodic nourishment. The amount of nourishment used for the beach can vary from year to year. The loss of material from April 1983 to April 1984 was approximately 1500 cubic yards. This is an estimate of one year and can vary from year to year. The coarser material will meet the criteria specified in the Shore Protection Manual. The selected plan will require approximately 1,100 cubic yards per year since the addition of the groin structures would also compartmentalize and reduce the losses of sandfill at the beach. This nourishment quantity is an estimated yearly average amount and would be performed as needed. The sandfill price estimate for future periodic nourishment is $9 per cubic yard in place. This estimate includes contingencies, engineering and design, and supervision and administration.

Use of annual periodic nourishment is for cost purposes only. The cost of nourishment will be shared on the same basis as the initial project cost sharing; that is 70 percent Federal and 30 percent nonlimitation. If the Federal cost, which includes all study costs for report preparation, investigation, supervision and administration, plus 70 percent of the share of construction costs and annual periodic nourishment is an excess of $1,000,000 all costs in excess of that limitation are non-Federal responsibilities. Periodically nourishing the beach will maintain and restore the beach to its constructed dimensions and replace the onshore and offshore losses that can occur. In the event of a major storm or a series of storms that could redistribute the sandfill causing it to accumulate along the beach, the sandfill should be redistributed back along the entire beach to avoid losses that can occur by overtopping the groin structure and depositing sandfill into Belfast Bay.

COST APPORTIONMENT

Federal participation in the costs of beach erosion control projects is based on shore ownership and use. Public-owned Shore Park and Conservation Areas are eligible for Federal cost sharing up to 70 percent of the construction cost providing the following criteria are met:

a. Must be publicly owned.

b. It includes a zone extending landward from the mean low waterline which includes all permanent human habitation but not including the residences of park administrative and maintenance personnel.

c. It includes a beach suitable for recreational use.

d. It provides for preservation, conservation and development of the natural resources of the environment in accordance with the overall mission or purpose of the park.

e. Extend landward a sufficient distance to include protective dunes, bluffs or other natural features to absorb and dissipate wave energy and flooding effects of the design storm tide.

f. It provides essentially full park facilities for appropriate public use.

Belfast City Park Beach satisfies all of the criteria and therefore, it is eligible for 70 percent Federal and 30 percent non-Federal cost sharing.

The apportionment of cost between Federal and non-Federal interests for the proposed improvement and periodic nourishment will be 70 percent Federal and 30 percent non-Federal. The apportionment of costs for the considered plans are summarized on Tables 3-8a and 3-8b of this section.

The currently estimated first cost of the selected plan is $363,000. The Federal share of this cost is $254,100 and the non-Federal share is 108,000.

The apportionment of the first costs, annual charges,and the cost of periodic nourishment for the selected plan (Plan 2) are displayed in Table 3-8b.

PLAN 2 - 50' BERM

FIRST COST		
Sandfill	18,000 c.y.(1) x $8/cy	$144,000
Terminal Groin	3,200 tons x $20/ton	64,000
Rock Revetment	900 tons x $20/ton	18,000
Beach Cleanup and Clam Reseeding	LUMP SUM	10,000
	SUBTOTAL	$236,000
Contingencies		47,000
	INITIAL CONSTRUCTION COST	$283,000
Engineering & Design		50,000
	SUBTOTAL	$333,000
Supervision & Administration		30,000
	TOTAL FIRST COST	$363,000

(1) Includes the quantities for the first year of periodic nourishment.

COST SHARING		
Federal Share	(70%)	$254,100
Non-Federal Share	(30%)	$108,900

Periodic Nourishment for 49 of 50 years Life of the Project

Cost per year	$9,900
Cost per 49 years	$485,100

Groin and Revetment Maintenance for 49 of 50 years Life of the Project (2)

Cost per year	$700
Cost for 49 years	$34,300
TOTAL PROJECT COST	$883,000

(2) Groin Maintenance is a non-federal cost only, therefore, it is not included in the federal share of the total project cost.

TABLE 3-8a
BENEFITS AND COSTS FOR CONSIDERED PLANS

Plan	Berm Width	Total Project First Costs	Annual Benefits	Annual Costs	B/C Ratio	Net Benefits
2	50	$363,000	$200,000	$40,900	4.9	$159,100
	75	$531,000	$242,000	$62,100	3.9	$179,900
	100	$726,000	$282,300	$86,500	3.3	$195,800
3	50	$321,000	$200,000	$41,500	4.8	$158,500
	75	$465,000	$242,000	$64,400	3.8	$177,600
	100	$628,000	$282,300	$89,700	3.2	$192,600

TABLE 3-8b
COST APPORTIONMENT FOR CONSIDERED PLANS

		First Cost		Annual Cost		AnnualPeriodic Nourishment	
Plan	Berm Width	Fed	Non-Fed	Fed	Non-Fed	Fed	Non-Fed
2	50	$254,100	$108,900	$28,100	$12,800	$6,900	$3,000
	75	$371,700	$159,300	$43,000	$19,100	$12,000	$5,100
	100	$508,200	$217,800	$60,000	$26,500	$17,000	$7,600
3	50	$224,700	$96,300	$28,800	$12,700	$10,100	$4,300
	75	$325,500	$139,500	$44,800	$19,600	$17,600	$7,600
	100	$439,600	$188,400	$62,500	$27,200	$24,800	$11,100

The Federal share in periodic nourishment, dune maintenance, construction, and study cost for the period of analysis, cannot exceed the $1,000,000 limitation.

Current estimates indicate that approximately $600,000 is available for the Federal share in periodic nourishment.

INVESTMENT COST

The investment cost is the total first cost plus the interest during construction. The interest during construction is the present 8 1/8 percent and the construction period is estimated to be three months. The investment cost was calculated assuming the total project cost was uniformly spend during the 3 month construction phase. Therefore the total investment cost is $365,000 and will be used for project justification.

ANNUAL CHARGES

Federal and Non-Federal Investment

Interest & Amortization	0.08291 x $365,000	$30,300
Nourishment (sandfill)	1100 c.y. x $9/c.y.	$ 9,900
Groin Maintenance	25 tons x $20/ton	$ 500
Revetment Maintenance	10 tons x $20/ton	$ 200
	TOTAL ANNUAL CHARGES	$40,900

TABLE 3-9

SYSTEM OF ACCOUNTS

ACCOUNT	**FOOTNOTES	PLAN 2		PLAN 3	
1. National Economic Development (NED)					
a. Beneficial Impacts (Annual)					
Increased Recreation and Travel Costs Saved					
50' Berm	2,5,7,9	$205,000		$205,000	
75' Berm	2,5,7,9	$247,000		$247,000	
100' Berm	2,5,7,9	$287,300		$287,300	
Non-Structural Plan	2,5,7,9	NONE		NONE	
Recreational Fishing	2,5,7,9	NONE		NONE	
Prevention of Loss of Land	2,5,7,9	-		-	
b. Project Costs (Annual)		Federal	Local	Federal	Local
50' Berm		$28,100	$12,800	$28,800	$12,700
75' Berm		$43,000	$19,600	$44,800	$19,600
100' Berm		$60,000	$26,500	$62,500	$27,200
Non-Structural Plan		NONE	NONE	NONE	NONE
(1) Total NED Costs (Annual)					
50' Berm		$40,900		$41,500	
75' Berm		$62,100		$64,400	
100' Berm		$86,500		$89,700	
Non-Structural Plan		NONE		NONE	

TABLE 3-9

SYSTEM OF ACCOUNTS

ACCOUNT	**FOOTNOTES	PLAN 2	PLAN 3
c. Total NED Benefits (Annual)			
50' Berm		$200,000	$200,000
75' Berm		$242,000	$242,000
100' Berm		$282,300	$282,300
Non-structural plan		NONE	NONE
d. Benefit-Cost Ratio			
50' Berm		4.9	4.8
75' Berm		3.9	3.8
100' Berm		3.3	3.2
Non-structural plan		NONE	NONE
2. Environmental Quality (EQ)			
a. Beneficial Impacts			
(1) Restoration of Valuable Beach using Sandfill from land source	2,6,9	yes	yes
(2) Protection of Recreational Facilities (new groins and sandfill will protect beach from erosion)	2,6,9	yes	yes
(3) Provision of Recreational Beach Area (Sandfill will provide increased beach area)	2,6,9	yes	yes
(4) Provision of Fishing Facilities (New groin structures)	2,6,9	no	no

TABLE 3-9

SYSTEM OF ACCOUNTS

ACCOUNT	**FOOTNOTES	PLAN 2	PLAN 3
(5) Prevention of Littoral Sand Drift (New groin structures)	2,5,9	no	somewhat
b. Adverse Impacts			
(1) Archaelogical/Historical Resources		no impact	no impact
(2) Air Quality (Increase in dust levels at site and on roads during construction.)	1,6	Minor-temporary	Minor-temporary
(3) Noise (Increased due to construction)	1,6	Minor-temporary	Minor-temporary
(4) Water Quality (Increases in turbidity during fill and construction activities may cause short-term decrease in the oxygen level in the water)	1,6	Minor-temporary	Minor-temporary
3. Other Social Effects			
a. Beneficial Impacts			
Effects on Desired Community Growth	2,5,8,9	Compatible with local land use to improve the backshore park.	
Effects on Educational, Cultural, and Recreational Opportunities		Increase recreational opportunities by providing additional dry beach space with increased capacity.	
Traffic (Interference on haul roads to the beach.)		temporary	temporary

TABLE 3-9

SYSTEM OF ACCOUNTS

ACCOUNT	**FOOTNOTES	PLAN 2	PLAN 3
b. Adverse Impacts			
Community Distruption	1,6,9	Temporary disruption during construction; site specific disruptions.	
Effects on Health, Safety, and Community Well-Being	1,6,9	Temporary threat during construction on local roads and areas at or near project site.	
4. Regional Economic Development			
a. Beneficial Impacts			
Effects on Regional Recreational Activity	2,5,9	Increase salt water based recreational opportunities.	
Effects on Employment	1,6,7,9	Use of local labor pool for construction of project.	
Effects on Local Commercial and Industrial Activities	2,4,9	Probable increase in business for local establishments resulting from increased numbers of beach users.	
b. Adverse Impacts			
Effects on Public Services	2,5,9	Possible need for increased police and life guarding services.	
Effects on Public Facilities	2,5,9	No effect	No effect

TABLE 3-9

SYSTEM OF ACCOUNTS

*PLANS	**FOOTNOTES
Considered Plans of Improvement Plans 2 and 3 consist of beach widening, to a level beach berm width of 50, 75, or 100 feet by the direct placement of suitable sandfill along approximately 550 feet of shoreline on Belfast Bay. There will also be 20 feet of rock revetment north of the northern groin structure and 20 feet south of the southern groin structure where a groin structure is being considered. The considered plans are: Plan 2- Sandfill and and construction of two terminal groin structures at the northern and southern limits of the beach. Plan 3- Sandfill and construction of a terminal groin structure at the northern limit of the beach.	<u>Timing</u> 1. Impact is expected to occur to or during implementation of the plan. 2. Impact is expected within 15 years following plan implementation. 3. Impact is expected in a longer time frame (15 or more years following implementation.) <u>Uncertainty 1/</u> 4. The uncertainty associated with the impact is 50% or more. 5. The uncertainty is between 10% and 50%. 6. The uncertainty is less than 10%. <u>Exclusivity</u> 7. Overlapping entry; fully monetized in NED account. 8. Overlapping entry; not fully monetized in NED account. 1/ Easily reversible measures are desirable cases where uncertainty of impact is high.

TABLE 3-9

SYSTEM OF ACCOUNTS

*PLAN	**FOOTNOTES
	<u>Actuality</u> 9. Impact will occur with implementation. 10. Impact will occur only when specific additional actions are carried out during implementation. 11. Impact will not occur because necessary additional actions are lacking.

TIDAL DATUM PLANES

BELFAST, MAINE

(BASED UPON CURRENTLY AVAILABLE, SHORT TERM, NATIONAL OCEAN SURVEY TIDAL BENCHMARK DATA FROM 1941-59 TIDAL EPOCH)

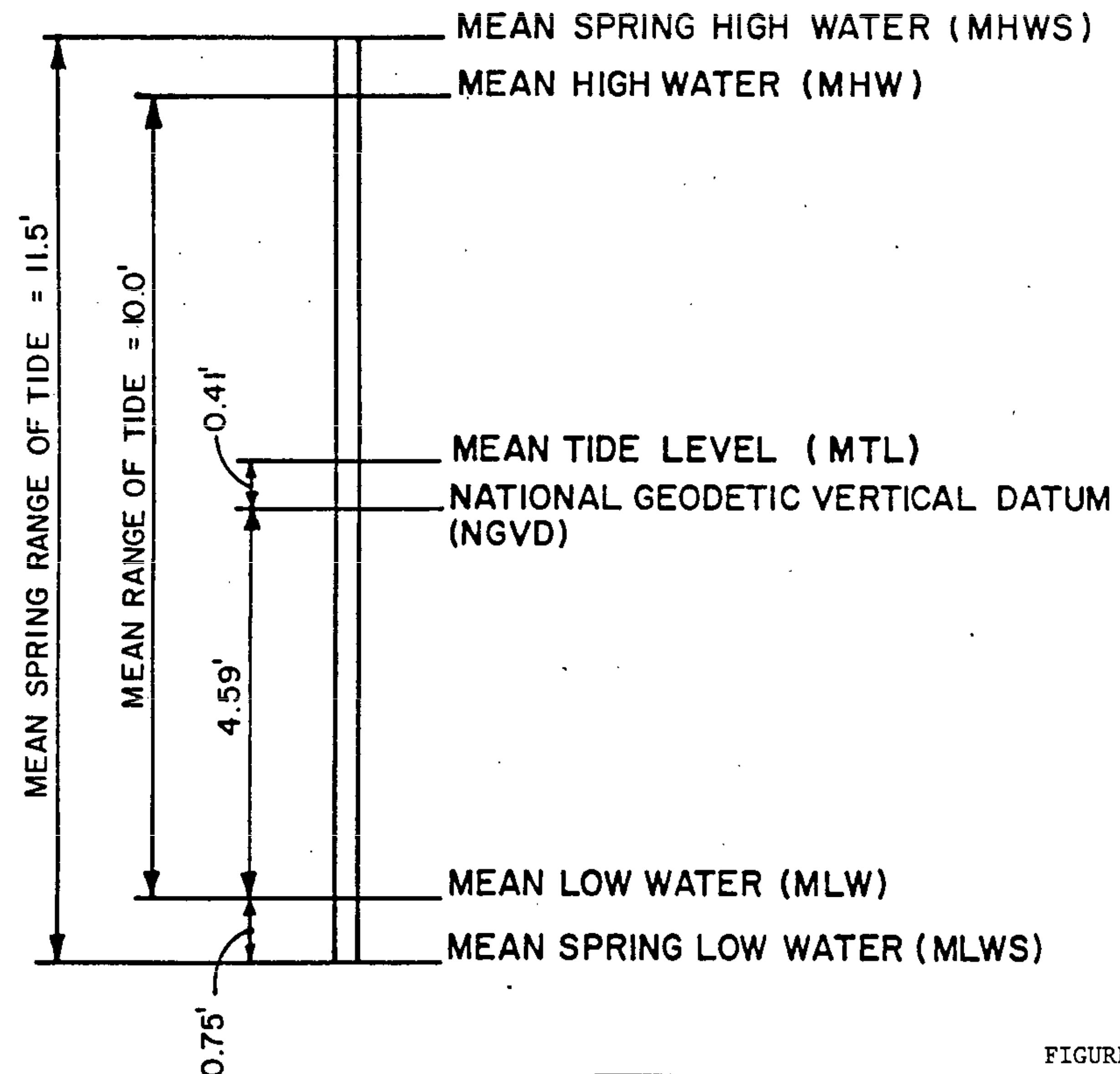


FIGURE 3-1

NEW ENGLAND DIVISION
U.S. ARMY, CORPS OF ENGINEERS
WALTHAM, MASS. MAR. 1984

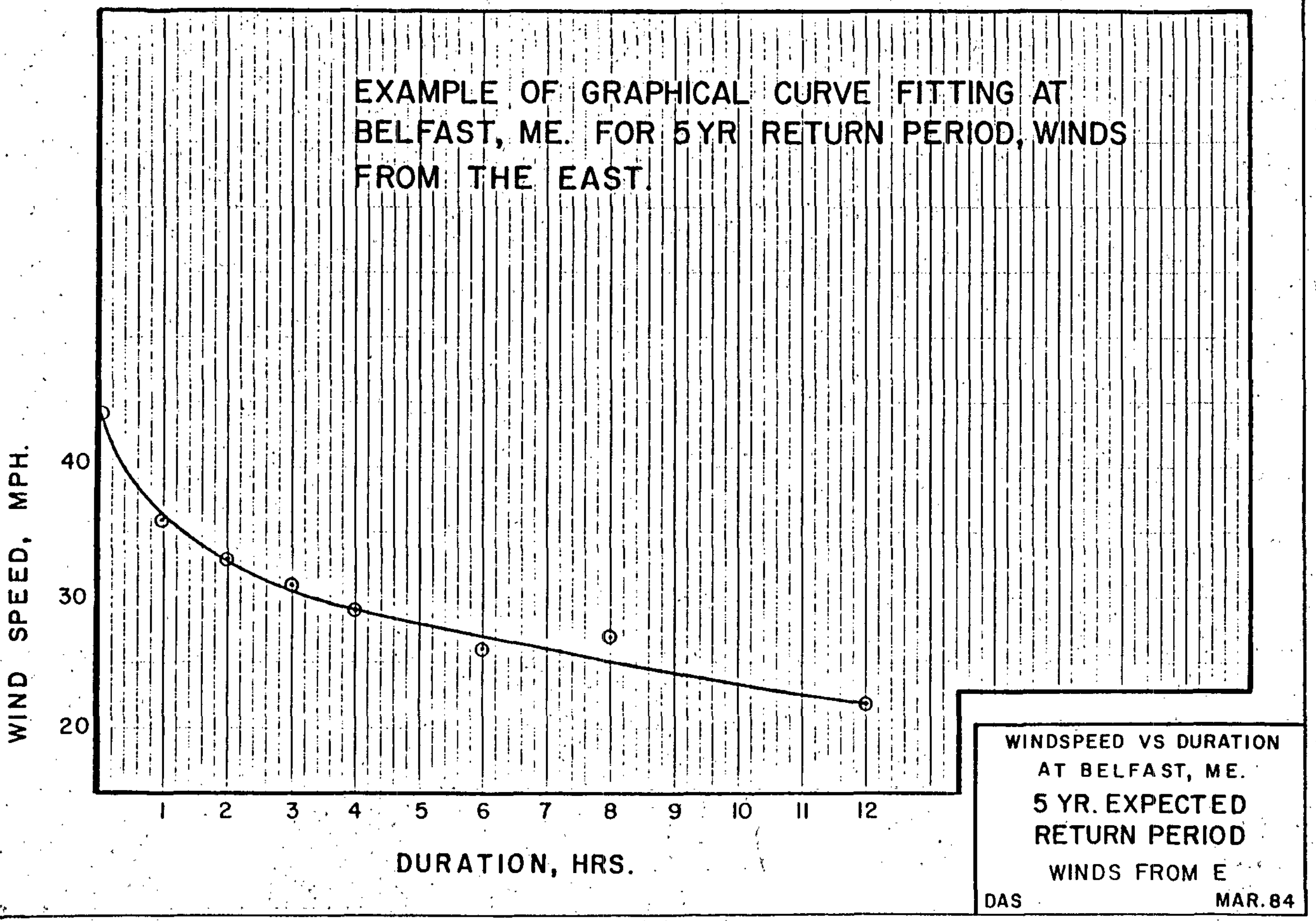
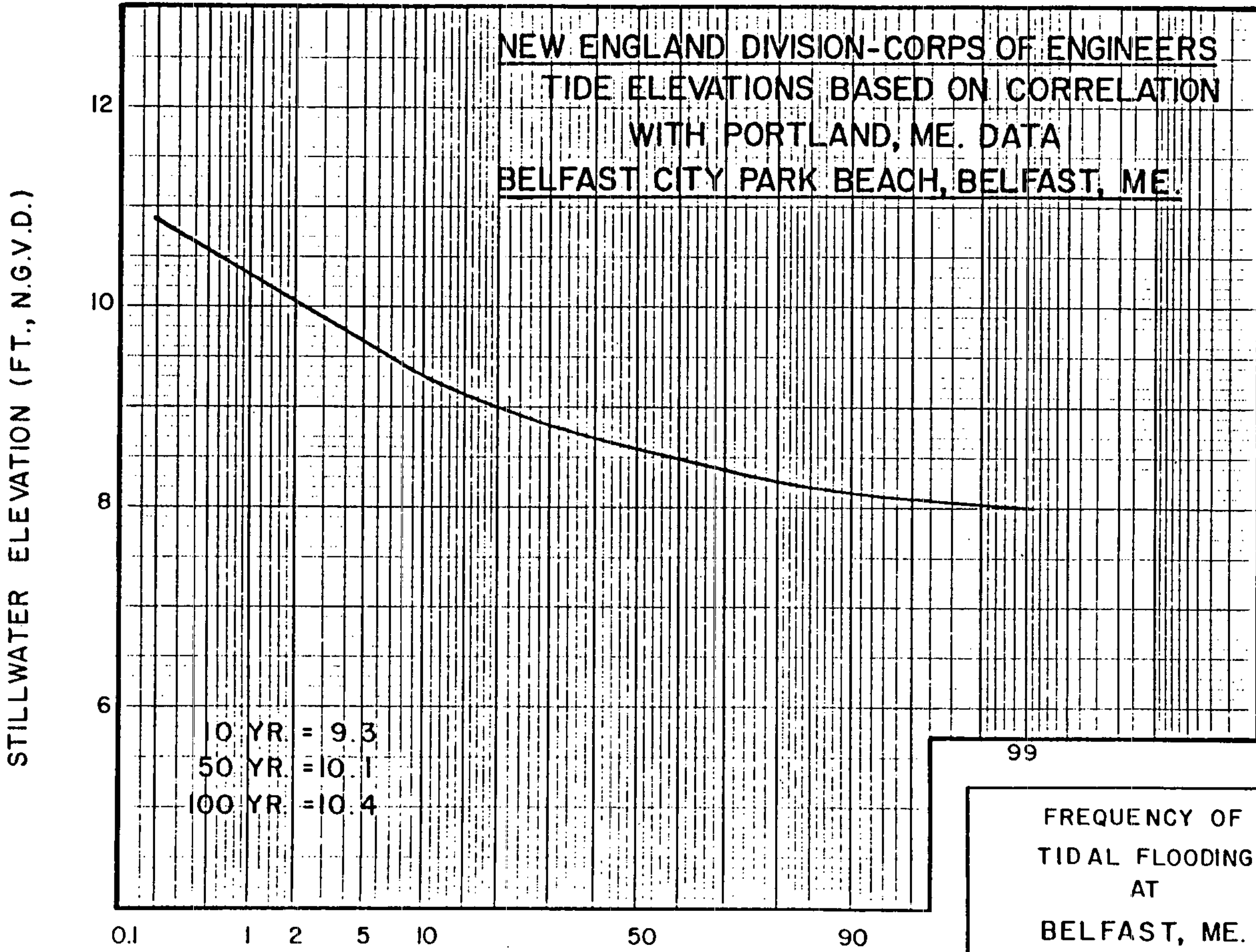

EXAMPLE OF GRAPHICAL CURVE FITTING AT BELFAST, ME. FOR 5 YR RETURN PERIOD, WINDS FROM THE EAST.
WIND SPEED, MPH.
40
30
20
1
2
3
4
5
6
7
8
9
10
11
12
DURATION, HRS.
WINDSPEED VS DURATION
AT BELFAST, ME.
5 YR. EXPECTED
RETURN PERIOD
WINDS FROM E
DAS
MAR. 84

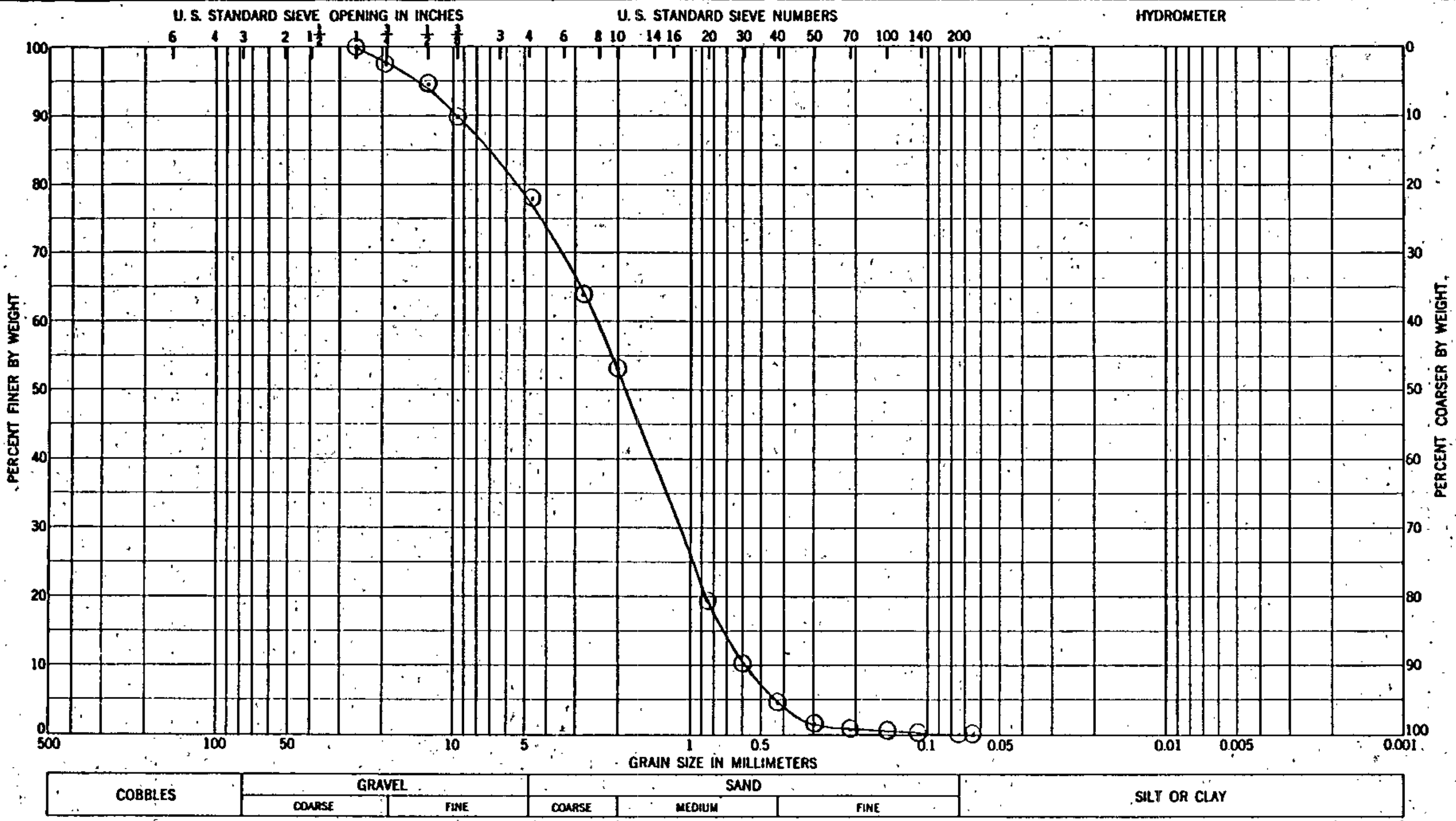
FIGURE 3-2



FREQUENCY OF
TIDAL FLOODING
AT
BELFAST, ME.

DAS MAR. 84

FIGURE 3-3



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-3 END of BEACH		Gray - gravelly c-m SAND (SP)				

Project BELFAST CITY PARK MAINE

Area

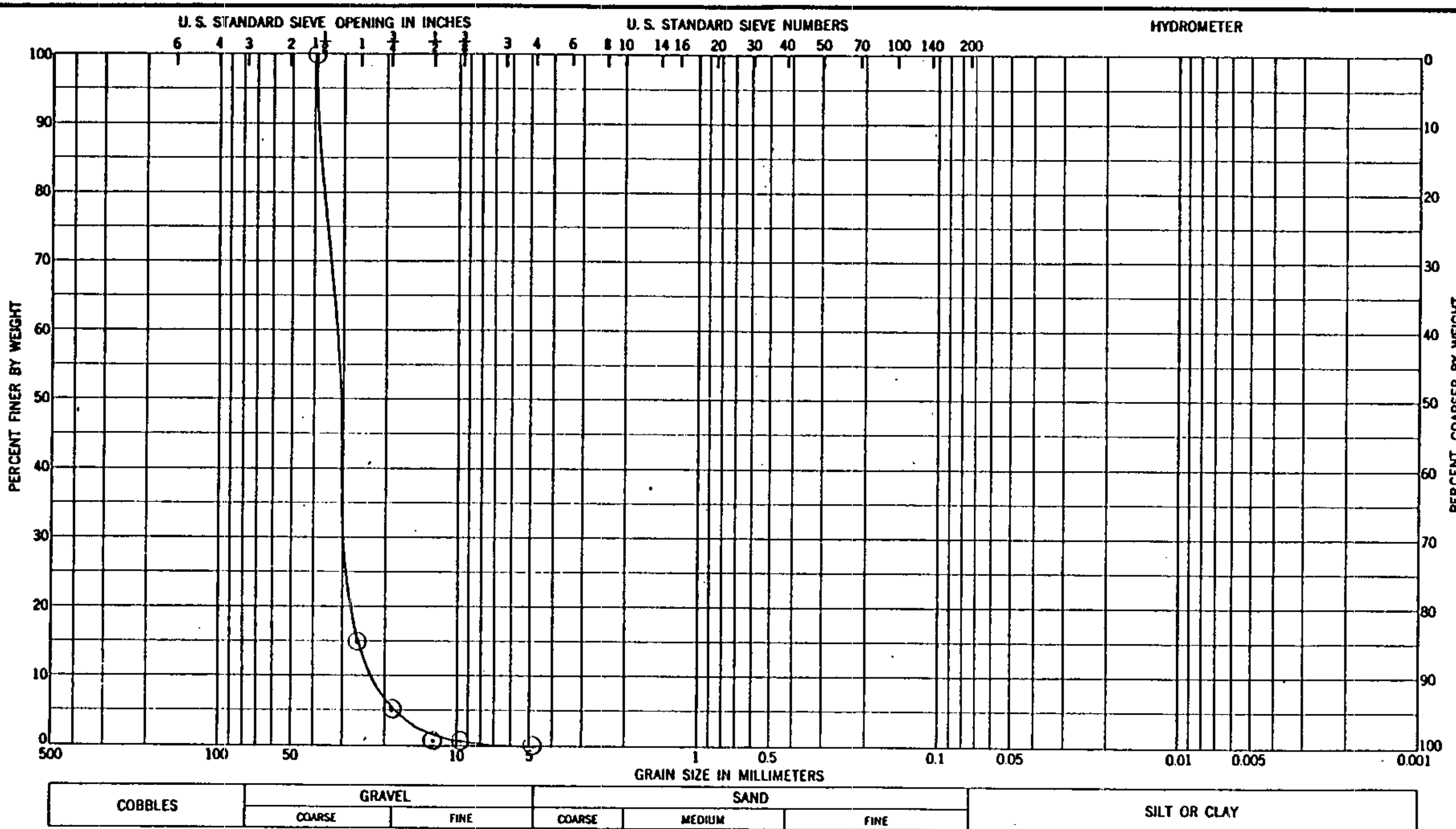
LAB SER Boring No. 68-36-4

Date 5/23/83

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-4



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-3						
12'		A FEW GRAVEL PIECES				

Project BELFAST CITY PARK
MAINE

Area

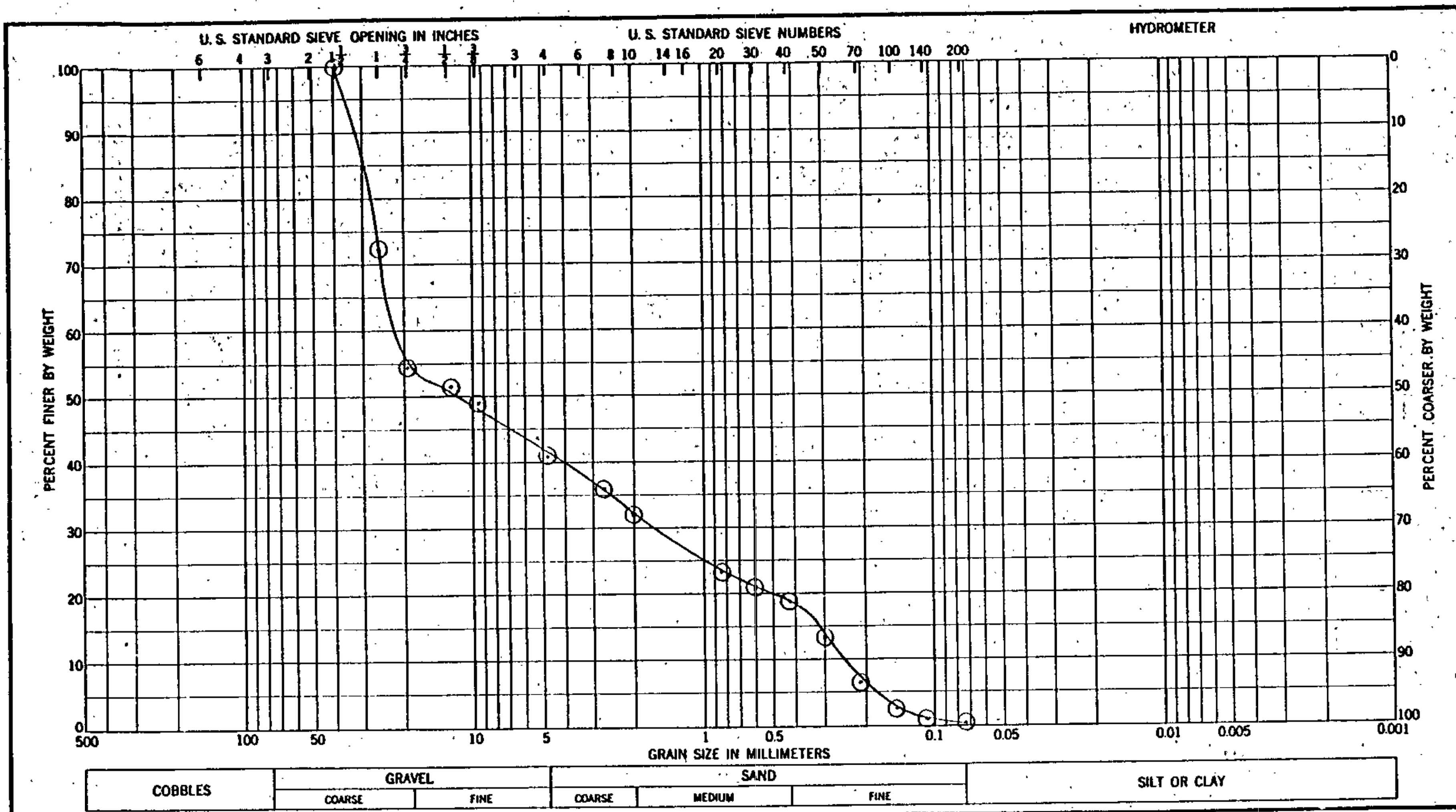
LAB SER
Boring No. 68-36-2

Date 5/23/83

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-5



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-3 MHW		Gray-sandy c GRAVEL (GP) w/shell frag				

Project BELFAST CITY PARK MAINE

Area ME SER

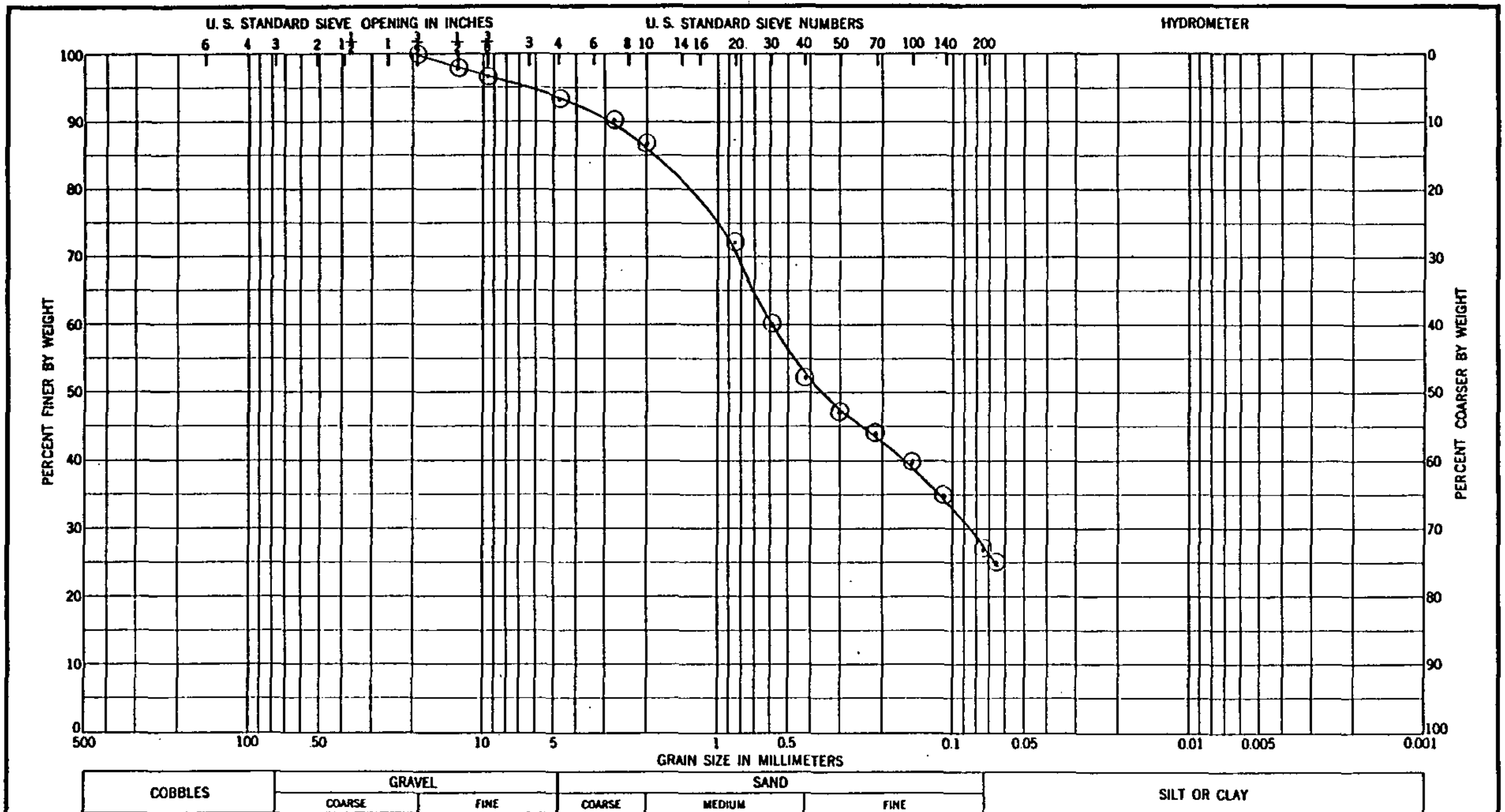
Boring No. 68-36-3

Date 5/23/83

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-6



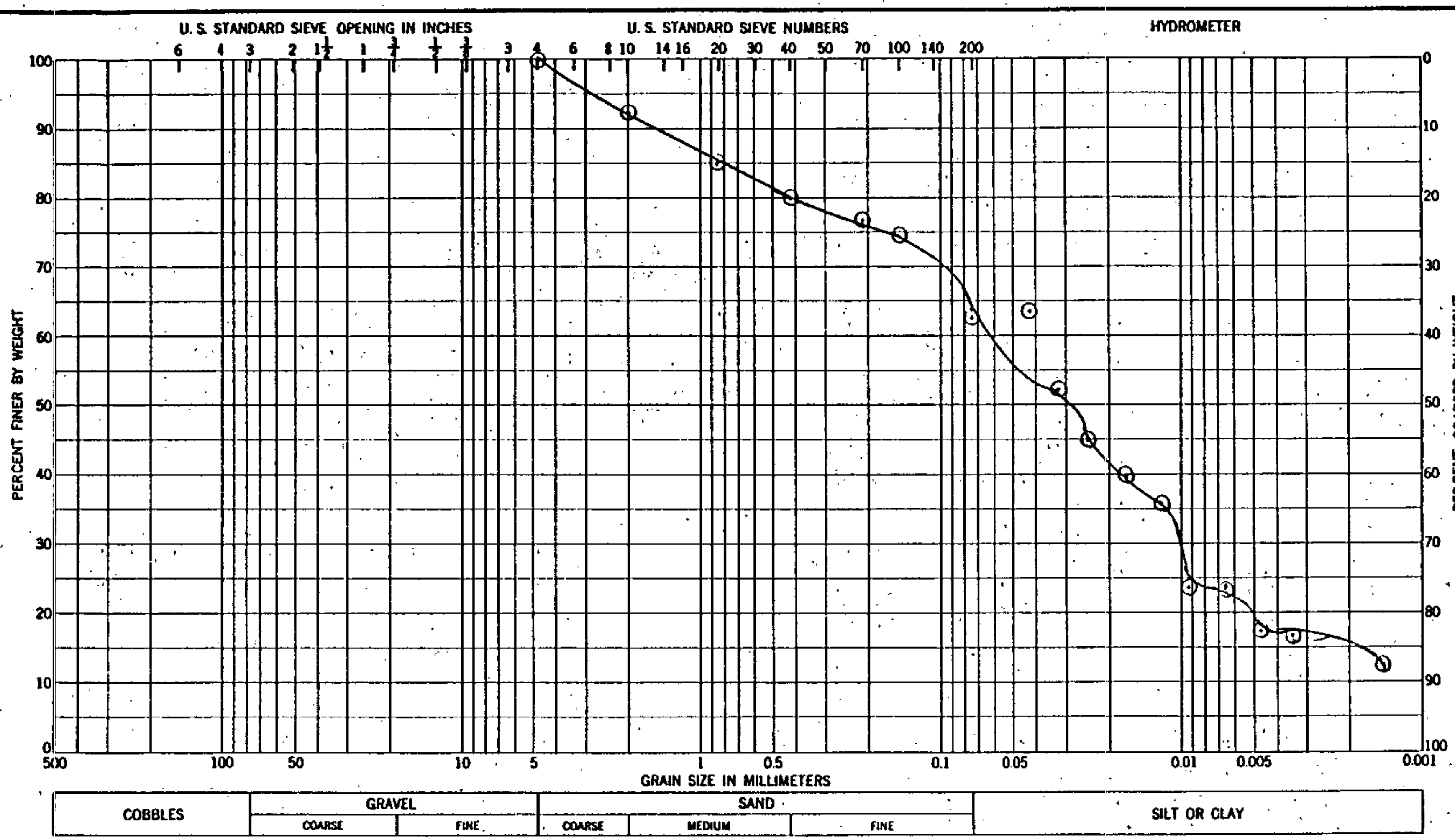
Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-5 END of BEACH		Gray - gravelly silty m-f SAND (SM)				

Project	BELFAST CITY PARK MAINE
Area	
LAB SER Boring No.	68-36-8
Date	5/24/73

GRADATION CURVES

FIGURE 3-

ENG FORM 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-5 12'		Black-org. sandy SILT(OL) w/mdr. odor				

Project BELFAST CITY PARK MAINE

Area US SER

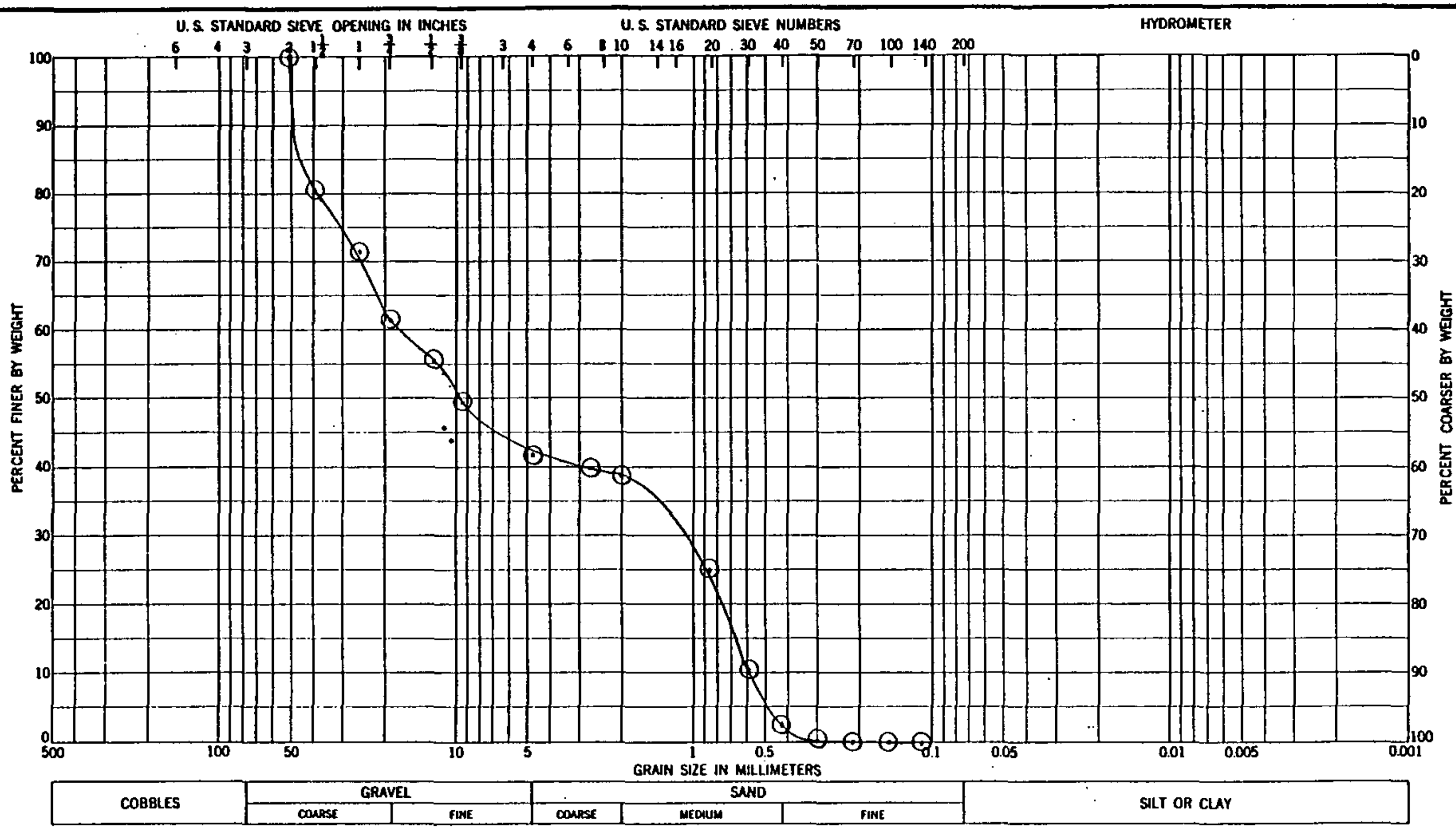
Boring No. 68-36-6

Date 6/3/83

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-8



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-5 MHW		Gray-sandy c-f GRAVEL (GP)				

Project BELFAST CITY PARK MAINE

Area LAB SER

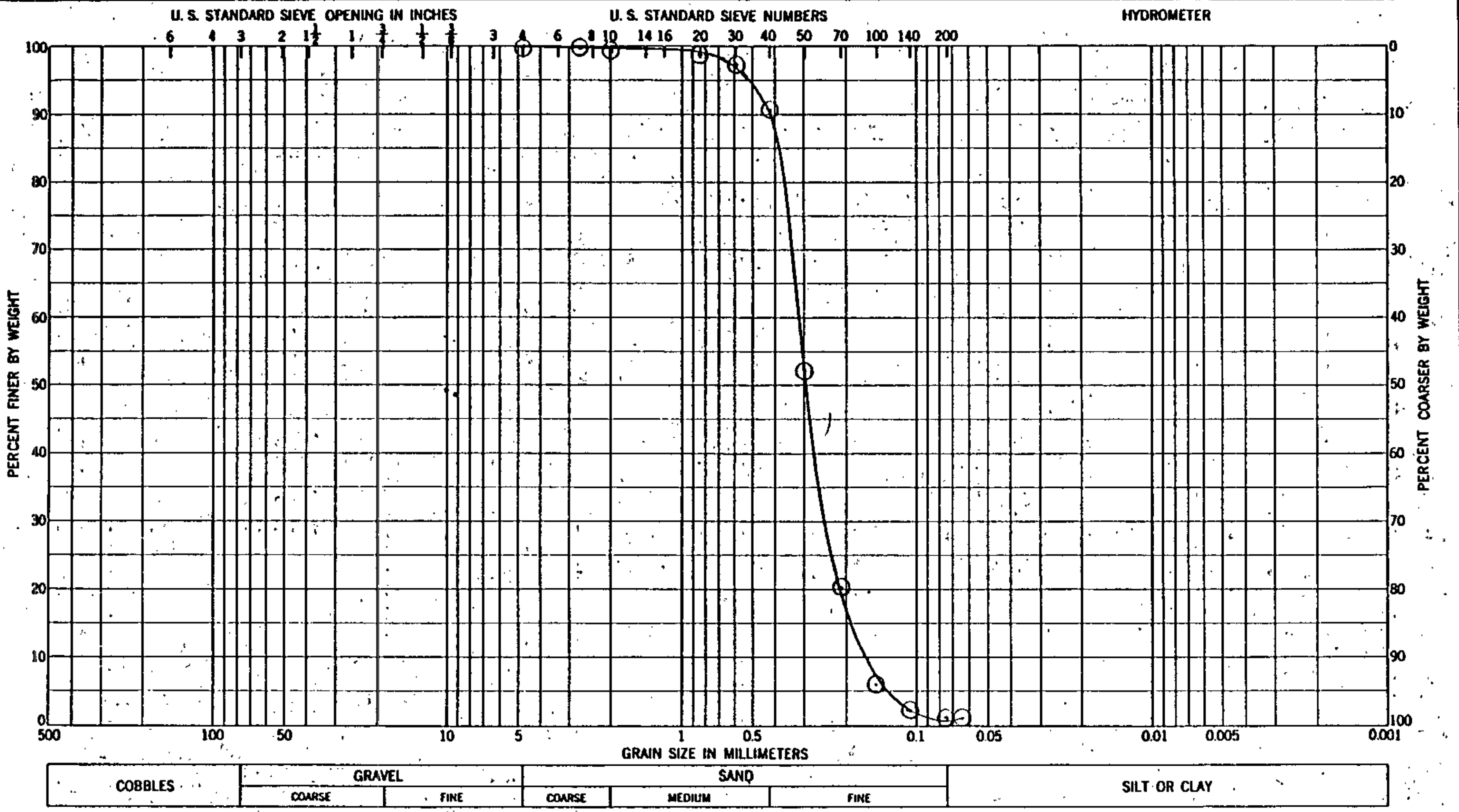
Boring No. 68-36-1

Date 5/23/83

GRADATION CURVES

ENG FORM 2087

FIGURE 3



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-5 6'		Gray - m-f SAND (SP)				

Project: BELFAST CITY PARK MAINE

Area

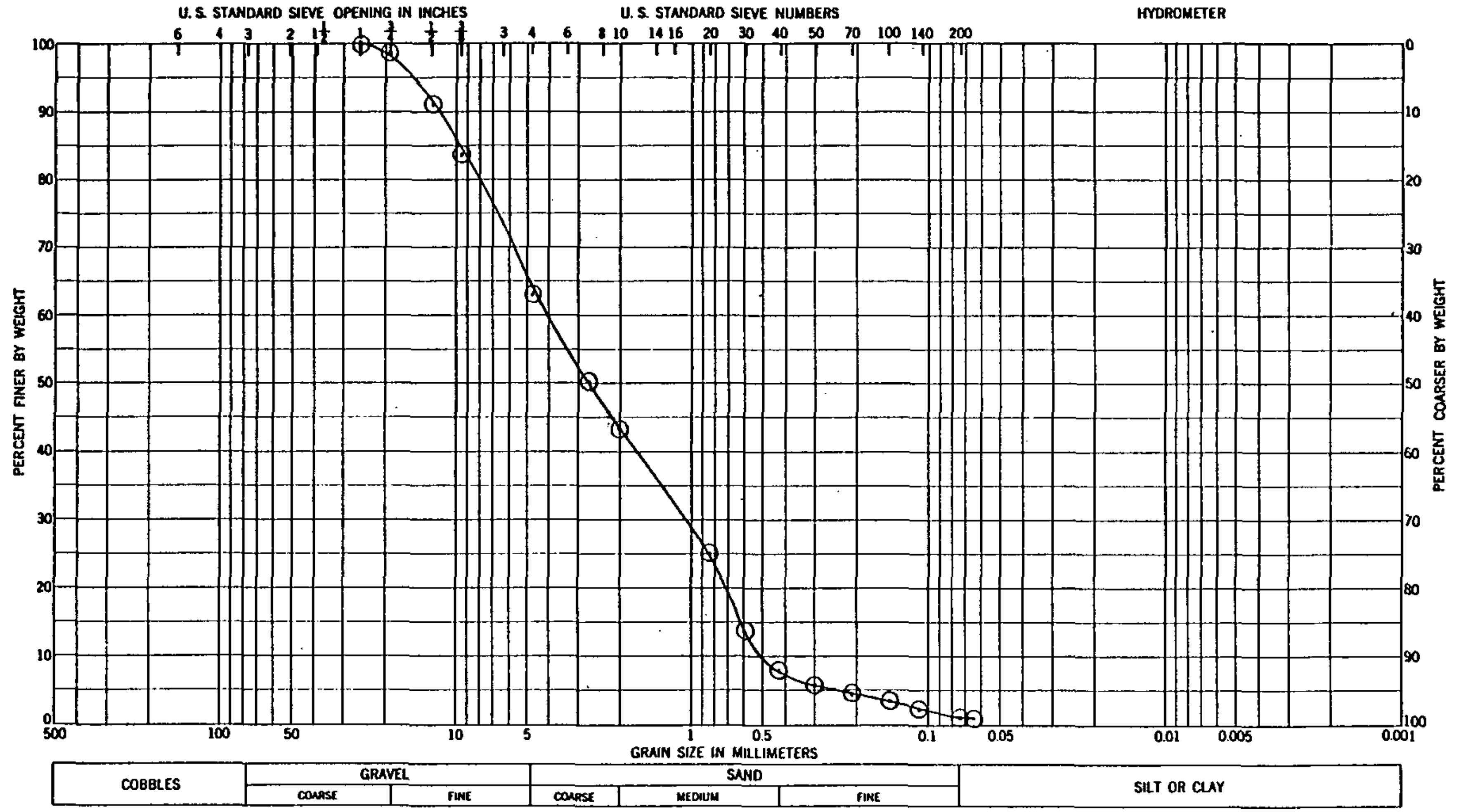
LAB SER Boring No. 68-36-5

Date 5/23/73

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-10



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-7		Gray-gravelly c-m SAND (SP)				
END of BEACH						

Project BELFAST CITY PARK MAINE

Area

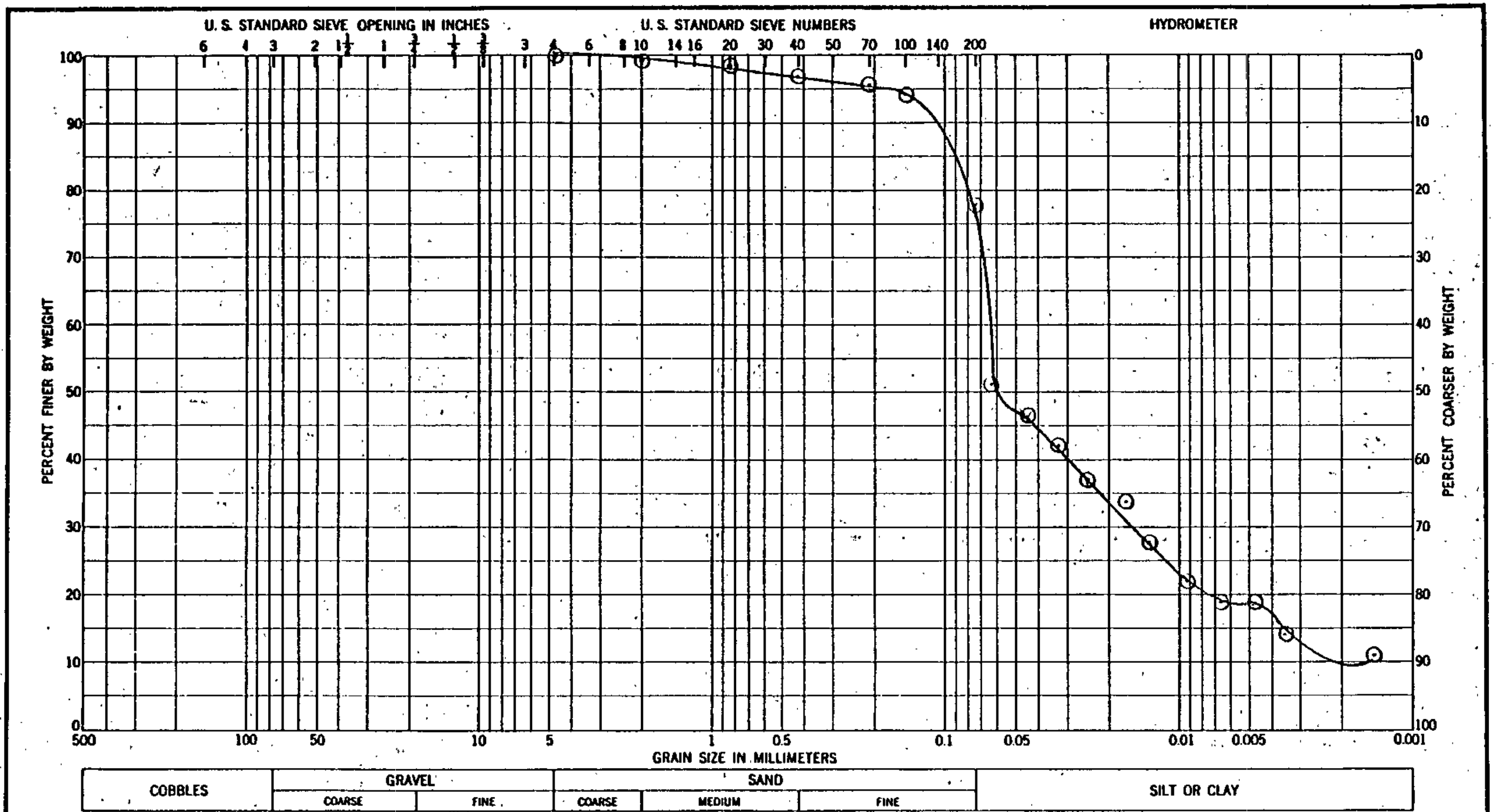
LAB SER Boring No. 68-36-12

Date 5/24/83

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
P-7 12'		Black-org. sandy SILT (OL) w/[illegible] odor				

Project BELFAST CITY PARK MAINE

Area

LAB SER Boring No. 68-36-10

Date 6/3/[illegible]

GRADATION CURVES

ENG FORM 1 MAY 63 2087

FIGURE 3-12

APPENDIX 4

SOCIAL AND ECONOMIC ANALYSES

SOCIAL AND ECONOMIC ANALYSES

TABLE OF CONTENTS

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APPENDIX 4
SOCIAL AND ECONOMIC ANALYSES

INTRODUCTION

This portion of the detailed project report is directed to the social and economic impacts related to implementation of a beach erosion control project at Belfast City Park Beach in Belfast, Maine. The first part of this assessment contains a description of the general social and economic characteristics of Belfast and a description of the City Park Beach area. In the next sections, future conditions without a project are identified, followed by a brief description of the alternatives under consideration. In the final sections, the impacts of project alternatives are discussed.

BASELINE CONDITIONS

Population

The city of Belfast had a 1980 population of 6,243, a 4.8 percent increase from 1970. Belfast is the largest community in Waldo County containing about 20 percent of the county's total population. County population increased 21.8 percent between 1970 and 1980. With a land area approximating 38.1 square miles, Belfast has a population of 164 persons per square mile. Whereas, population in Belfast has shown little change since 1950, the county's population has increased about 31.0 percent. Population for Belfast, Waldo County, and the State are provided in Table 4-1.

From 1930 to 1960, Belfast's population increased at a decreasing rate. From 1960 to 1980, population had greater fluctuations. A decline in population occurred between 1960 and 1970, while the 1970's brought with it growth. This influx of people during the 1970's was due to a movement of people seeking a self-sustaining lifestyle, desiring to recapture a simple way of life. Many people especially in the mid to late 1970's, moved to farms.

Economy

Major industries in the Belfast Labor Market Area (LMA) are poultry and shoe manufacture. Major employers in the area include Belfast Manufacturing (skipants and jackets), Penobscot Frozen Food (baked stuffed potatoes, potato skins), Penobscot Poultry (poultry processing) Stinson

TABLE 4-1

POPULATION

BELFAST, WALDO COUNTY, STATE OF MAINE

1930-1980

	Belfast		Waldo County		State of Maine	
	Number	Percent change from previous decade	Number	Percent change from previous decade	Number	Percent change from previous decade
1980	6,243	4.8	28,414	21.8	1,124,660	13.2
1970	5,957	-3.0	23,328	2.6	993,722	2.5
1960	6,140	3.0	22,632	4.4	969,265	6.1
1950	5,960	7.6	21,687	2.5	913,774	7.9
1940	5,540	11.0	21,159	4.3	847,226	6.2
1930	4,993		20,286		797,423	

Source = U.S. Census

Canning (sardines), Truitt Brothers (men's shoes), and Waldo Shoe (women's dress shoes). Belfast's labor force totals 2,358 (March, 1983). However, unemployment, a chronic problem throughout the county, is 16.6 percent. The LMA's labor force totals 10,670 with 16.4 percent unemployment. Market fluctuations in the narrow industrial base have resulted in frequent lay-offs of workers. Because of the large number of unemployed workers, job training programs and hiring incentive programs are a high priority in the LMA.

The closing of the Maplewood Poultry processing plant in 1979 made a large contribution to the unemployment problem by eliminating 700 jobs from the area. One reason for the closing of the Maplewood plant was its inability to compete with other firms in the industry: Maplewood faced higher transportation costs than did its competitors located in Maryland, Delaware, and Virginia.

The 1980 U.S. Census has made available a breakdown of employment by industry for both Belfast and LMA residents. This data is provided in Table 4-2. For the most part residents in Belfast are employed similarly to those throughout the LMA.

TABLE 4-2
EMPLOYMENT BY INDUSTRY, 1980
BELFAST AND BELFAST LABOR MARKET AREA

	Belfast		LMA	
Industry	Number	Percent	Number	Percent
Agric., Forestry, Fisheries & Mining	28	1.3	572	5.7
Construction	62	2.8	691	6.9
Manufacturing	660	30.2	2,810	28.0
Trans., Comm., and Utilities	138	6.3	654	6.5
Wholesale Trade	46	2.1	253	2.5
Retail Trade	394	18.0	1,484	14.8
Finance, Ins., and Real Estate	58	2.7	240	2.4
Services	653	29.8	2,693	26.9
Public Administration	150	6.8	627	6.3
Total	2,189	100.0	10,024	100.0

Land Use

Belfast has a land area of 38.1 square miles, accounting for almost 5 percent of the county's land area. The city is basically a residential community with a concentration of commercial/tourist type activities on the east side of the city towards Ellsworth. Limited commercial activity including some small shopping areas providing local services can be found on the west side of town.

City Park Beach

Belfast City Park Beach is isolated on Belfast Bay south of the central city area. Because of private property lying north and south, the beach is limited to a 550-foot stretch of shorefront. The beach consists of medium to coarse sand upon which large rocks are presently scattered. A eight to fifteen foot embankment protects the backshore area, but there is some evidence of erosion during storm condition.

The backshore area is a publicly owned and maintained park approximately 28.5 acres. The park is bordered on both the north and south by private property. Belfast City Park offers a wide range of recreational opportunities and is visited by residents from all points of the county as well as from Belfast. Major park attractions are a 3,000 square foot swimming pool, 2 tennis courts with lighting, and a baseball field. Park benches, picnic tables, bathroom facilities, and water fountains are situated throughout the park at various convenient locations. Access to the park is via Route 1. A parking lot with a 50 car capacity is provided.

FUTURE CONDITIONS

Population

Population projections obtained from the Maine Office of State Planning provide a 10 year projection from a 1981 estimated population for Belfast and Waldo County. The projections indicate a population decrease of 17.5 percent for Belfast and an increase of 2.1 percent for the county. This population trend projected for Belfast indicates migration contrary to recent trends, which have been a population shift from large cities to smaller communities. However, the projections indicate a migration of people out of Belfast and into the more densely populated areas.

The projections show a declining trend for Belfast because of the shift of large industries from comparably rural areas to larger cities. This shift has been due in part to the high transportation costs encountered in shipping the products from rural areas. It is assumed that this shift in industry has also impacted retail trade and activity in the Belfast area. Although the projections reflect a continuation of recent trends, Belfast is seeking to improve the potential for industrial location and continued development of retail activities.

Growth and Development

In establishing a community strategy, city planners have identified the economic revitalization needs of Belfast. The chronic and severe unemployment, the decline of the downtown commercial area, and the misuse of the Belfast waterfront are the three areas to which solutions are being sought.

The development of an industrial park in Belfast was recommended by a consultant to the city as a priority for job generation. Although much planning as well as site selection activities have taken place, the residents recently voted down the allocation of local funds for construction of an industrial park on the east side of town. The local officials found the proposed location of the industrial park unsuitable. It was not the industrial park itself that was objected to, but the proposed location. It is anticipated, however, that the location problem can be remedied.

Further industrial development involves an electric plant on Sears Island, located in Belfast Bay. The project consists of Central Maine Power constructing an electric generating plant, which would allow for the production of cheaper electricity and would be an incentive for new industry. This project has been in the planning stages for fifteen years, and it would be another ten years after approval before completion of the generating plant.

Revitalization of the downtown commercial area has been a focus of planning activity. The opening of a new Ames Department Store seemed to indicate that residents could be drawn back into the downtown. Efforts to make the downtown area a more attractive place and to encourage location of complementary activities appear to be a priority. Proposed funding in the Maine Department of Transportation's budget for improvement on Belfast's Main Street presents a timely opportunity. Anticipated industrial development would support new commercial development.

The Belfast waterfront has a history of misuse. The numerous studies done over the years seem to focus on changing the waterfront from current, inappropriate industrial uses to recreational and commercial uses. With exhaustion of available facilities along the coast both north and south of Belfast, there appears to be a demand for increasing activity in the Belfast Harbor area. Both public and private interests have joined together to guide development of the waterfront area. Their first step is to gain control of specific parcels of land. Improvement of public facilities is essential in inducing private investment. The city is seeking funds to renovate the city dock to improve recreational uses, to construct a riprap pier to protect the dock and provide facilities for larger vessels and onshore support facilities.

WITH PROJECT CONDITIONS

Six plans are under consideration for solving the Belfast City Park Beach erosion problem. Four of these plans involve sandfill, three of which require the use of groin structures. The two remaining plans do not alter the existing beach area. The plans that consider groin structures will have rock revetment 20 feet north of the north groin structure and 20 feet south of the south groin structure.

Plan 1 - Sandfill only.
Plan 2 - Sandfill and 2 terminal groin structures.
Plan 3 - Sandfill and groin structure at northern end.
Plan 4 - Sandfill and groin structure at southern end.
Plan 5 - Rock revetment along entire backshore.
Plan 6 - Offshore breakwater.

Three berm sizes are being considered for Plans 1 through 4: a 50' berm, a 75' berm, and a 100' berm. Each berm would, of course, result in a different beach size, with varying capacity. Supply and demand figures have been presented in the economic analysis.

Alternatives can be assessed by comparing their ability to respond to study objectives. These objectives can be summarized as follows: prevent erosion of the existing beach area, provide protection to the backshore park area, and improve the recreational opportunity along the beach.

After a brief assessment of the alternatives, Plans 5 and 6 show obvious weaknesses in meeting the objective for prevention of shore erosion. Plan 5, construction of a rock revetment along the backshore, would not prevent erosion and would not improve the recreational opportunity on the beach. It would, however, protect the backshore after the beach has been lost to erosion. Under Plan 5, it is estimated that the beach would be completely eroded in a 10 year period.

Plan 6, construction of an offshore breakwater, would reduce the rate of erosion and provide limited protection to the backshore area, although it would not improve the recreational opportunity on the beach. The rate of erosion would be reduced by half its current rate, and therefore extend the life of the beach from 10 years to almost 20 years. After 20 years, damages to the backshore area would be expected to begin, although again at a slower rate than under existing conditions.

Plans 1 through 4 basically have the same effects on the beach area. The rate of erosion is not altered, however, the effects of erosion are reduced by placement of sandfill which is included in each plan. By slowing down the effects of erosion with periodic maintenance, protection to the backshore areas would be provided. In addition, these plans greatly improve the recreational opportunity offered by the beach. Various groin schemes are being examined in Plans 2 through 4 to determine if greater stabilization of the beach can be gained. These schemes would also be examined for their effects on neighboring property.

Increased beach capacities which would result from the various plans are provided in the economic appendix. The berm width, however, would be the controlling factor for capacity variation; i.e. each plan would offer the same capacity width of 50', 75', and 100' berm. With a 50' berm, capacity would be increased from 147 persons to 1,643 persons. This provides a new beach supply of 61,600 sq./ft. A 75' berm increases beach capacity from 147 persons to 1,980 persons. The 75' berm yields an area of 74,300 sq./ft. of beach. The 100' berm would increase beach capacity from 147 persons to 2,304 persons resulting in 86,400 sq./ft. of beach.

Over the short term, a variety of construction related impacts would be felt in the local area. These impacts would be restricted to a time frame approximating the months needed for construction, and the time required for periodic maintenance. The construction period would be shortest for Plan 1, 3 months, and longest for Plan 6, 9 months. In all plans it is assumed that material would be trucked in via Route 1 through the park to the shorefront. Confining construction to nonsummer months would reduce the effects on park visitors. Construction, however, would affect local residents along and near the shore. The area would experience increased levels of noise and air pollution. These impacts are not expected to be significant.

The city is extremely supportive of the opportunities an improved beach could provide. The city is also willing to assume responsibility for additional facilities, such as parking and bathhouses that would be needed. It is also expected that a ripple-type effect would be felt through the local economy by attracting countywide residents. The limited availability of saltwater beaching in the Belfast area would increase the attractiveness of Belfast Beach.

ECONOMIC ANALYSIS

METHODOLOGY

The principal methodology underlying the economic justification of the proposed improvements result in a comparison of benefits accruing to the project and project costs. In this comparison, the benefits and costs were placed on an equivalent annual basis using the interest rate and amortization rate of 8-1/8%. The interest rate was chosen in accordance with specifications found within the Economic and Environmental Principles and Guidelines for Water and Related Land Resource Implementation Study, effective as of February 3, 1983.

All benefits and costs are calculated using October 1983 price levels. The projects' economic life span is considered to be fifty years. The three possible categories of benefits which may arise are: (1) prevention of loss of land, (2) prevention of damage to backshore structures, (3) additional improvements to recreational opportunity.

There are six improvement plans under consideration for Belfast City Park Beach. They differ in scope, impact and cost. The plans are listed below:

PLAN 1: Consists of beach widening, to a level beach berm width of 50, 75, or 100 feet, by placement of suitable sandfill along approximately 550 feet of shoreline. This plan also includes continued beach nourishment.

PLAN 2: Consists of the same sandfill procedure as in Plan 1, along with construction of two terminal groin structures. One groin will be placed at the northern limit of the study, and the other groin will be placed at the southern limit of the study. There will also be 20 feet of rock revetment north of the northern groin structure and 20 feet south of the southern groin structure.

PLAN 3: Consists of beach widening to a level beach berm width of 50, 75, or 100 feet, by placement of suitable sandfill along approximately 550 feet of shoreline. A terminal groin at the northern end of study area limit will also be constructed with 20 feet of rock revetment north of the structure.

PLAN 4: Consists of a beach widening to a level beach berm width of 50, 75 or 100 feet, by placement of suitable sandfill along approximately 550 feet of shoreline. A terminal groin structure at the southern end of the study area limit will also be constructed with 20 feet of rock revetment south of the structure.

PLAN 5: Consists of placement of rock reventment along the entire backshore area.

PLAN 6: Consists of the construction of an offshore breakwater 1000 feet offshore, with a length of approximately 780 feet long.

Plans 1-4 involve sandfill. Sandfill which creates a 50-foot berm results in a useable beach area of 61,600 square feet. A 75 foot berm results in a 74,300 square feet beach and a sandfill which creates a 100 foot berm results in a useable beach space of 86,400 square feet.

Recreation

The chief benefit derived from the beach erosion control project (Plans 1 through 4) at Belfast City Park would be improved recreational opportunities. Other benefits derived would be prevention of loss of land and prevention of damages to backshore areas.

The recreational benefits will depend upon the relative supply and demand for beach space within the area. A relevant primary market area is the city of Belfast. However, use of the park and its facilities extends to the population beyond the city limits. Thus, a secondary market area has developed which extends beyond the city itself to the Belfast Urban Area. Therefore, the benefit-cost analysis for Belfast City Park Beach will be viewed in a regional content.

The Belfast Urban area encompasses a 20-mile radius around the city. As means of transportation, visitors to the park and beach either walk, cycle, or drive. The populations of communities within the Belfast Urban Area for both 1970 and 1980 are presented in Table 4-3.

TABLE 4-3
POPULATION WITHIN THE BELFAST URBAN AREA

City of Town	1970 Population	1980 Population	Percentage Change
Belfast	5957	6243	4.8
Bucksport	3756	4345	15.7
Winterport	1963	2675	36.3
Searsport	1951	2309	18.3
Blue Hill	1367	1644	20.3
Orchard	1307	1645	25.9
Unity	1280	1431	11.8
Stockton Springs	1142	1230	7.7
Castine	1080	1304	20.7
Lincolnville	955	1414	48.1
Penobscot	786	1104	40.5
Brooks	751	804	7.1
Northport	744	958	28.8
Burham	802	951	18.6
Brooksville	673	753	11.9
Palermo	645	760	17.8
Searsmont	624	782	25.3
Frankfort	620	783	26.3
Sedgwick	578	795	37.5
Troy	543	701	29.1
Liberty	515	694	34.8
Swanville	487	873	79.3
Monroe	478	657	37.1
Knox	443	558	26.1
Thorndike	439	603	37.4
Waldo	431	495	14.8
Montville	430	631	46.7
Isleboro	421	521	23.8
Morrill	410	506	23.4
Freedom	373	458	22.8
Belmont	349	520	49.0
Prospect	358	511	42.7
Jackson	217	346	59.4

BEACH SPACE: SUPPLY AND DEMAND

Beach Supply

Belfast is located within the boundaries of the Maine Eastern Mid Coast Regional Planning District. The April 1983 Maine State Comprehensive Outdoor Recreational Plan (SCORP) indicates that a sufficient capacity for ocean swimming exists in the Mid-Coast Planning District. The Mid-Coast Planning District is comprised of the Southern Planning Commission and Eastern Planning Commission sectors. Although there is a sufficient capacity overall for the entire Mid-Coast Planning district, it is insufficient for the Eastern sector.

Existing beach capacity that is publicly owned and developed for recreation is inventoried in the April 1983 SCORP. The results of this inventory are found in Table 4-4.

TABLE 4-4
EXISTING COASTAL BEACHES

	Municipality	Name of Beach	Beach Frontage (feet)	Parking Capacity (cars)
Southern Planning Commission	Phippsburg	Popham	8,300	440
	Georgetown	Reid 1/2 mile	1,386	800
	Georgetown	Reid Mile	3,432	Included in 800 above
	Boothbay	Knicker Kane Island	100	Unknown
	Bristol	Pemaquid	1,485	Unknown
	Bristol	Fish Point	412	Unknown
Subtotal			15,115	
Eastern Planning Commission:	Owls Head	Birch Point (undeveloped)	1,345	30
	Camden	Barretts Cove	27	Unknown
	Camden	Lands End	50	Unknown
	Lincolnville	Lincolnville	500	Unknown
	Northport	Wyman Park	198	10
Subtotal			2,120	
	TOTAL:		17,235	

The existing capacity within the Eastern Planning Commission sector is limited. Of the 17,235 feet of beach frontage available, only 2,120 feet or 12% is located within the Eastern Planning Commission.

The primary concern for the recreational aspect focuses on the supply of salt water public beach space. Within the Belfast Urban area the only public salt water beach of any significance is Lincolnville Beach. Lincolnville Beach is 12 miles south of the city of Belfast. The beach length is 500 feet long, although only 400 feet is suitable for recreational activity. The facilities offered at Lincolnville Beach are limited, with a beach parking capacity of 25 to 30 cars. Immediately adjacent to the beach is a small grassy park area with several picnic tables. As for bathhouse facilities, they are non-existent at the beach. Lincolnville is also a non-supervised beach.

Although official attendance records are not available for Lincolnville Beach, it has been indicated by local officials that local use of Lincolnville Beach is at a minimum, on both peak and non-peak days. It has been commented by local officials that more tourists use the beach than the locals due to the beaches location which is directly off U.S. Route 1. As for available beach supply, Lincolnville has a beach capacity of approximately 374 people. (An allowance of 75 square feet per bather and total useable recreational square footage of beach, with a turnover factor of 2 was used to calculate beach supply.) A turnover factor of 2 was determined since most users spend either the morning or afternoon at the beach and beach space may be said to turn over once a day.

Currently there is no public inland or ocean swimming facility of any significance in the city of Belfast. At present, the existing beach at Belfast City Park has a dry beach area of approximately 5,500 square feet of very coarse and rocky terrain. Given the present condition this dry beach area would supply a capacity of 147 people.

The beach is eroding at approximately 1 ft/yr of 550 sq. ft./year. At this rate the beach will be completely eroded and provide zero beach capacity in 10 years. This is shown in Table 4-5.

TABLE 4-5
CAPACITY (SUPPLY)
W/O PROJECT

Dry Beach Area: 5,500 sq. ft.
Allowance for Maximum Benefit per visit: 75 sq. ft.
Turnover Factor: 2
Daily Capacity: 147
Erosion Factor: 1 ft/yr 550 sq. ft./yr.

Year	Area	Capacity
1983	5,500	147
1984	4,950	132
1985	4,400	117
1986	3,850	103
1982	3,300	88
1988	2,750	73
1989	2,200	59
1990	1650	44
1991	1100	29
1992	550	15
1993	-0-	-0-
2033	-0-	-0-

Nor is there at present any attendance records kept for the beach and park. In the past the park once had a salt water swimming pool. However, that was abandoned ten years ago with construction of a new 3000 gallon fresh water swimming pool. The pool has a maximum capacity of 150 people and there are eight full time life guards employed. Various swimming programs are offered throughout the summer with use of the pool open to the public for a small registration fee of one dollar.

Beach Demand

As indicated by government officials, Belfast City Park services not only local needs, but also needs outside the community and receives much regional use. It is for this reason that the area of study extends beyond the city of Belfast to encompass towns within the Belfast Urban Area (BUA). Towns included in the study were those in Waldo County and towns in southeastern Hancock County. Information found in the 1983 SCORP pertaining to beach demand indicates (based on a survey of recreation and leisure preferences) that 21.2% of the people in the Mid Coast Planning District participate in ocean swimming activities away from the backyards or camps. For this analogy it is assumed that 21.2% of the people in the Belfast urban area would swim. In addition, the average number of participation days is estimated to be 14.7 per year.

This figure has been applied to 1980 population data to derive the annual demand estimates for the Belfast Urban Area which are presented in Table 4-6.

TABLE 4-6
BELFAST URBAN AREA ANNUAL DEMAND FOR OCEAN SWIMMING

City or Town	1980 Population	Estimated Demand for Ocean Swimming (Activity Day/Yrs)
Belfast	6243	19456
Bucksport	4345	13540
Winterport	2675	8336
Searsport	2309	7196
Orland	1645	5126
Blue Hill	1644	5123
Unity	1431	4460
Lincolnville	1414	4407
Castine	1304	4064
Stockton Springs	1230	3833
Penobscot	1104	3440
Northport	958	2986
Burham	951	2964
Swanville	873	2721
Brooks	804	2506
Sedgwick	795	2478
Frankfort	783	2440
Searsmont	782	2437
Palermo	760	2368
Brooksville	753	2347
Troy	701	2185

Liberty	694	2163
Monroe	657	2047
Montville	631	1966
Thorndike	603	1879
Knox	558	1739
Isleboro	521	1624
Belmont	520	1621
Prospect	511	1592
Morrill	506	1577
Waldo	495	1543
Freedom	458	1427
Jackson	346	1078
TOTAL:	40,004	124,668

Due to the lack of local facilities, most of the annual demand estimated in Table 4-6 is assumed to be unmet. It is assumed that 1/4 of the demand is marginally satisfied by the limited facilities in Lincolnville and the undeveloped Belfast site. Also the quality of recreational provided by these sites is not believed to provide optimum value.

Annual demand is broken down to daily demand assuming an 80-day swimming season which extends from late June to early September. Of this 80 days however, 25% or 20 days are eliminated by reason of inclement weather; these benefits are calculated on a season of 60 good weather days. Of the 60-day season, 35 days are considered average days while 25 days are considered peak days. It is assumed that demand on peak days is double the demand on average days. Daily demand estimates for ocean swimming in Belfast and the Belfast Urban Area are presented in Tables 4-7 and 4-8.

TABLE 4-7
CITY OF BELFAST
DAILY DEMAND FOR OCEAN SWIMMING

	People		Days in Season	Activity Days/Yr.
Marginally Satisfied Demand				
Peak Day	115	x	25	2875
Average Days	57	x	35	1995
Subtotal:				4,870
Unsatisfied Demand				
Peak Days	343	x	25	8575
Average Days	171	x	35	5985
Subtotal:				14,560
Totals:				
Peak Days	458	x	25	11450
Average Days	228	x	35	7980
			TOTAL:	19,430

TABLE 4-8
BELFAST URBAN AREA
(WALDO COUNTY & PARTS OF SOUTHEASTERN HANCOCK COUNTY)

DAILY DEMAND FOR OCEAN SWIMMING

	People		Days in Season	Activity Day/Yr
Marginally Satisfied Demand				
Peak Days	702	x	25	17,550
Average Days	351	x	35	12,285
Subtotal:				29,835
Unsatisfied Demand				
Peak Days	2102	x	25	52,550
Average Days	1052	x	35	36,820
Subtotal:				89,370
Totals				
Peak Days	2804	x	25	70,100
Average Days	1403	x	35	49,105
			TOTAL:	119,205

Recreational Benefits

Recreational benefits for this study were developed in accordance with the Economic and Environment Principles and Guidelines for Water and Related Resources Implementation Studies, March 10, 1983; "Section VIII - NED Implementation Studies." The estimated value of recreational use is determined using the unit day value approximation of willingness to pay. The value of a park and beach visit at present has been estimated at $2.37 for those who use the facilities at Belfast. The nineteen acres of Belfast City Park located just outside of the downtown district accommodates such activities as baseball, tennis, basketball, fresh water swimming, picnicking and passive recreation. It is the unique mix of conditions which explains the higher non-project unit day value. Under the with project condition for Plans 1 through 4, the value of a visit to the park and beach has been estimated at $2.58. The increase in unit day value resulting from the improved beach is $.21, the difference between the UDV of without project and with project conditions.

An increase in the unit day value under the with project condition is primarily due to the addition of the high quality activity-public salt water swimming. As for the additional costs involved with a larger carrying capacity it was agreed that the locals, to the best of their knowledge at present, will provide the additional bathhouse and parking facilities needed. Also, with a sandy beach present there becomes an "above average" aesthetic and experience quality.

The points used in developing these estimates are outlined in Tables 4-9 and 4-10.

WITHOUT / WITH
PROJECT / PROJECT

TABLE 4-9

Guidelines for Assigning Points For General Recreation

Criteria	Judgment factors				
(a) Recreation experience [1] 5/6	Two general activities [2]	Several general activities	Several general activities; one high quality value activity [3]	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Total points: 30 Point value:	0–4	5–10	11–16	17–23	24–30
(b) Availability of opportunity [4] 7/7	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18 Point value:	0–3	4–6	7–10	11–14	15–18
(c) Carrying capacity [5] 3/4	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total points: 14 Point value:	0–2	3–5	6–8	9–11	12–14
(d) Accessibility 11/11	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total points: 18 Point value:	0–3	4–6	7–10	11–14	15–18
(e) Environmental quality 3/5	Low esthetic factors [6] exist that significantly lower quality [7]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total points: 20 Point value:	0–2	3–6	7–10	11–15	16–20

[1] Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
[2] General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
[3] High quality value activities include those that are not common to the region and/or Nation and that are usually of high quality.
[4] Likelihood of success at fishing and hunting.
[5] Value should be adjusted for overuse.
[6] Major esthetic qualities to be considered include geology and topography, water, and vegetation.
[7] Factors to be considered to lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Table VIII–3–3—Guidelines for Assigning Points For Special Recreation

Criteria	Judgment factors				
(a) Recreation experience [1]	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users, rarely if ever crowded	Very low evidence of other users, never crowded
Total points: 30 Point value:	0–4	5–10	11–16	17–23	24–30
(b) Availability of opportunity [2]	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total points: 18					

TABLE 4-10
CONVERSION OF POINTS TO DOLLAR VALUES

Activity Category	Point Values										
	0	10	20	30	40	50	60	70	80	90	100
General Recreation	1.6	1.9	2.1	2.4	3.0	3.4	3.7	3.9	4.3	4.6	4.8

Points from Table	Without Project	29 Points = 2.37
	With Project	33 Points = 2.58

Annual recreation benefits are determined by subtracting recreational value under the without project condition from recreational value with the project.

BELFAST BEACH WITHOUT PROJECT

Recreational value under the without project condition assumes 1/4 of the demand for Belfast Urban Area is met by facilities at Lincolnville and underdeveloped Belfast Beach. Recreational benefits for Belfast Beach without the project were calculated on a current, useable beach area of 5,500 square feet. Erosion and increasing demand will continue and supply will be unable to accommodate demand in the year 1993. Supply, the physical accomodation of demand for beach space will have declined over a ten year period to zero. The area will then be exposed to an additional loss, the loss of park land valued at $24,000 an acre. The dollar value loss of land was calculated to be $200 on an average annual equivalent basis over a fifty year period. Average annual recreational value of Belfast Beach without the Corps project is estimated to be $4,898.

The dollar value of the maximum potential recreational value of Belfast Beach was determined by assuming that present full beach capacity is 147 people. Given a total daily demand of 1053 people who are marginally satisfied ocean swimmers within the Belfast Urban area (702 on peak days and 351 on week days) it is assumed that Belfast Beach is used to a level of full capacity on peak days. It is estimated that approximately two-thirds of its capacity is used on week days.

The recreational value was derived in the following manner for two various interest rates.

Number of people per peak day	=	147 people
Number of people per non-peak day	=	98 people
Number of peak days per season	=	25 days
Number of non-peak days per season	=	35 days

Unit day value without project condition	=	$2.37
Number of years from project implementation to complete beach erosion	=	8 years
Sum of present worth (PW) with 8-1/8% interest rate	=	28.06792
Capital Recovery Factor (CFR) for 8-1/8% interest rate	=	.08291

Computation of Recreational Values at 8-1/8% interest rate

Peak Day Recreational Value

147 x 25 x $2.37	=	$8,710
$8,710/8	=	1,089
$1,089 x 28.06792 x .08291	=	$2,534

Non-Peak Day Recreational Value

98 x 35 x $2.37	=	$8,129
$8,129/8	=	$1,016
$1,016 x 28.06792 x .08291	=	$2,364

$4,898 total recreational value of the without project condition at 8-1/8%

BELFAST BEACH WITH PROJECT

Essential to the computation of the recreational values was the discounting procedure. Discounting was necessary since the beach supply was not constant over the project life due to erosion. Demand for ocean swimming was assumed to remain constant throughout the project life. This assumption was based on population projections obtained from OBERS and the population projections obtained from the State of Maine Department of Human Services. Given the population projections over the project life time there occured no significant population changes. Thus, the population of the Belfast Urban Area is assumed to be constant for this analysis. The demand for ocean swimming is derived from population projections. With population projections remaining constant then it is assumed that the demand for ocean swimming will also be constant. With-the-project recreational values were calculated for seven alternative plans. Plans 1 through 4 involve sandfill implementation of three specific berm widths of 50', 75' or 100', along with various groin structure implementation strategies. Not only will the sandfill implementation prevent loss of land by erosion, but it will also provide recreational benefits. Plan 5 involves rock revetment along the backshore, which prevents loss of land and damage to the backshore. However, it does not prevent beach erosion. With Plan 6, construction of a breakwater slows down the estimated rate of shore erosion to approximately .5 feet per year. The breakwater does not eliminate the problem of shore erosion nor does it eliminate the loss of land.

Plans 1 through 4 which use sandfill create three specific recreational values. Each specific berm size yields a maximum capacity of beach supply for all four plans. In all cases, the recreational demand of the Belfast Urban Area serves as an upper limit to benefits.

Total maximum number of people per peak day for the Belfast Urban Area	=	2,303
Total maximum number of people per non-peak day for the Belfast Urban Area	=	1,535
Unit day value of with project condition	=	$2.58
# of peak days per season	=	25
# of non-peak days per season	=	35

TABLE 4-11
RECREATIONAL VALUE WITH THE PROJECT

Beach Users

BERM	CAPACITY		BELFAST URBAN AREA		UNIT DAY VALUE		DAYS		TOTAL	
50'	1,643	Peak Days:	1,643	X	$2.58	X	25	=	$105,974	
		Non-Peak Days:	1,095	X	$2.58	X	35	=	98,879	
		TOTAL							$204,853	Total recreational value of plans 1-4 with 50' Berm
75'	1,980	Peak Days:	1,980	X	$2.58	X	25	=	127,710	
		Non-Peak Days:	1,320	X	$2.58	X	35	=	119,196	
		TOTAL							$246,906	Total recreational value of plans 1-4 with 75' Berm
100'	2,303	Peak Days:	2,303	X	$2.58	X	25	=	$148,544	
		Non-Peak Days:	1,535	X	$2.58	X	35	=	$138,611	
		TOTAL							$287,155	Total recreational value of plans 1-4 with 100' Berm

TABLE 4-12
ANNUAL RECREATIONAL BENEFITS FOR PLANS 1-4

	Use of Sandfill		
Recreational Value	50' Berm	75' Berm	100' Berm
with Project	$204,853	$246,906	$287,155
without Project	4,898	4,898	4,898
Annual Benefit	$199,955	242,008	$282,257

Plan 5 involves the construction of a rock revetment structure along the backshore. Implementation of this structure would prevent loss of backshore land. However, this structure does not prevent shore erosion. The rate of erosion to the shore will remain 1 ft/yr with implementation of this structure. At this rate the beach will completely erode and provide zero beach capacity by year 1993 as shown on Table 4-5.

Plan 6 involves the construction of a breakwater. Implementation of this structure will only slow down the rate of erosion caused by wave motion from 1 ft/yr to 0.5 ft/yr and extend the life of the existing beach.

At this rate the beach will completely erode and provide zero beach capacity by year 2001. This is shown in Table 4-13.

TABLE 4-13

CAPACITY (Supply)

WITH PLAN 6 - CONSTRUCTION OF OFFSHORE BREAKWATER

YEAR	AREA	CAPACITY
1983	5,500	147
1984	4,950	132
1985	4,400	117
1986	4,125	110
1987	3,850	103
1988	3,575	95
1989	3,300	88
1990	3,025	81
1991	2,750	73
1992	2,475	66
1993	2,200	59
1994	1,925	51
1995	1,650	44
1996	1,375	37
1997	1,100	29

1998	825	22
1999	550	15
2000	275	7
2001	-0-	-0-
2033	-0-	-0-

Thus, this plan does not offer complete protection to loss of land or shore erosion.

The dollar value to loss of land on an average annual equivalent basis with the breakwater amounts to $175.

Existing recreational benefits are also extended with the breakwater plan. In driving the recreational values of this plan, it is once again assumed that Belfast Beach accommodates 147 people at full capacity. It is estimated that approximately two-thirds of the 147 people use the beach on weekdays.

The recreational value was derived in the following manner for two various interest rates:

# of people per peak day	= 147 people
# of people per non-peak day	= 98 people
# of peak days per season	= 25 days
# of non-peak days per season	= 35 days
Unit day value of with project condition	= $2.37
# of years from project implementation to complete beach erosion	= 18 years
Sum of present worth (PW_{18}) with 8-1/8% interest rate	= 107.18552
Capital recovery factor (CRF_{50}) for 8-1/8%	= 0.08291

Computation of recreational values at 8-1/8% interest rate.

I. Peak Day Recreational Value

147 X 25 X 2.37 = $8,710

$8,710/18 = $484

$484 X 107.18552 X 0.08291 = $4,301

II. Non-Peak Day Recreational Value

98 X 35 X $2.37 = $8,129

$8,129/18 X 107.18552 X 0.08291 = $4,013
$8,314

* Total Recreational value of the with project conditions at 8-1/8% interest rate.

Annual Recreational Benefits for Plan 6

	8-1/8% interest rate
Recreational Value	
with project	$8,314
without project	4,898
Annual Benefit	$3,416

APPENDIX 5

CORRESPONDENCE RECEIVED PRIOR TO ISSUANCE OF THE DRAFT DETAILED PROJECT REPORT

TIME & TIDE
RC&D

MAINE

Resource Conservation & Development Project

U.S. ROUTE 1 WALDOBORO, MAINE 04572 TEL. 207-832-5348

November 13, 1980

Mr. Tom Bruha
Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Tom,

I am attaching a copy of a topo map showing the location of the Belfast City Park, as you requested yesterday in our phone conversation. This site is about 600-700' long on the bay and receives considerable erosion. The park is very heavily used and is owned by the City of Belfast.

I am not sure if the city is interested in developing a beach, but they do want to control the shore erosion. I will pass on the information to the city manager that the Corps will cost share 70% on a beach construction. They may be interested.

If your department isn't able to assist with the shore erosion problem, would you put me in contact with someone who may be able to help.

Also, I am sending a topo showing the location of the shore erosion in Rockport. This is about 15-20' from a paved road and is about 75' long. The Town of Rockport wants to do something on it soon.

Please let me hear from you as soon as possible.

Sincerely,

Norris

Norris D. Braley
RC&D Coordinator

Attachments

cc: Fred Breslin, Belfast City Manager
Paul Weston, Rockport Town Manager
Tom Smith, SCS, Belfast
Dick Howard, SCS, Rockland

CITY OF BELFAST, MAINE 04915

FRED T. BRESLIN
City Manager

20 November 1980

Mr. Thomas Bruha
Army Corps of Engineers
424 Trapelo Road
Waltham, Mass. 02154

Dear Mr. Bruha,

I would refer to Mr. Braley's letter of 13 November 1980 and state unequivocally that the City of Belfast is vitally interested in controlling the shore erosion problem at the Belfast City Park. I cannot be as certain relative to the development of a beach, only because I am completely ignorant of the projected costs of such a development.

Is there a possibility that the Corps might conduct a study in order to determine what needs to be done to establish a public beach and what estimated costs of such a project might be? Would such a study involve any costs to the City?

Thank you very much for your consideration of this matter.

Very truly yours,

Fred T. Breslin

Fred T. Breslin
City Manager

FTB/vmt
cc: Norris Braley

TIME & TIDE
RC&D
Resource Conservation & Development Project

US ROUTE 1 WALDOBORO MAINE 04572 TEL 207-832-5348

December 18, 1980

Fred Breslin, Manager, Belfast
Paul Weston, Manager, Rockport
Charles Kellogg, DEP
Walter Foster, Biologist, DMR
Tom Smith, District Conservationist, SCS, Belfast
Dick Howard, District Conservationist, SCS, Rockland

Tom Bruha of the Army Corps of Engineers in Waltham, Massachusetts, has informed me that he will arrive at Bangor International Airport at 9:51 a.m. on Tuesday, January 6, 1981. Arthur Dearborn, SCS, Orono, will pick him up and bring him to Belfast. We will plan to meet at the City Manager's office at 11:30 a.m., at which time arrangements will be made to visit the City Park shore erosion problem.

We will plan to meet at the Rockport Town Office at 2:30 p.m., where we will go to visit a shore erosion site in that town.

Tom will be taken back to Bangor by Art Dearborn in time to make his 5:55 p.m. flight to Boston.

Looking forward to seeing all of you on Tuesday, January 6. If there is any reason you can't attend, please let me know.

Sincerely,

Norris

Norris D. Braley
RC&D Coordinator

cc: Tom Bruha, Army Corps of Engineers
Art Dearborn, SCS, Orono
Art Taylor, SCS, Orono

I gave ART DEARBORN your phone #
I expect he will call you.

Hope you have a good Xmas & New year

Mr. Carrigan/mc/554

NEDPL-C 9 February 1981

SUBJECT: Belfast City Park, Belfast, Maine

HQDA (DAEN-CWP-E)
WASH, DC 20314

1. A reconnaissance scope investigation has been initiated for the subject area.

2. Initial funding of $7,500 has been established under the revolving fund account, as specified in ER 1105-2-50 for the preparation of this report, with later reimbursement under Section 103 Beach Erosion Control Authority.

FOR THE DIVISION ENGINEER:

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Deputy Division Engineer

cc: Executive Office
Mr. Ignazio
Coastal Dev. Br.
Reading File
Planning Div. File

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NEDPL-C	Trip Report - Belfast City Park Beach Belfast, ME

TO	FROM	DATE	CMT 1
Division Engineer	Douglas Carrigan Coastal Development Branch	13 August 1981 Carrigan/jm/737	

THRU: Channels

1. On Thursday, 6 August, Douglas Carrigan and Joseph Mancini of the Coastal Development Branch visited Belfast City Park Beach in Belfast, Maine. The purpose of this visit was a reconnaissance level site inspection as well as a fact-finding tour.

2. Messrs. Carrigan and Mancini arrived at Belfast City Park at 11:00 a.m. and commenced the site inspection. The inspection included the backshore park facilities, the immediate foreshore area and the private shoreline extending north and south of Belfast City Park.

3. Site inspection revealed that the park facilities are excellent and are very well maintained. The foreshore area, however, is badly eroded and very rocky. At high tide there is no usable dry beach space at the park and there is evidence of the water encroaching upon the embankment fronting the park. Backshore facilities include parking areas, a swimming pool, a ballfield, playground equipment (swings, etc.), picnic areas, a bathhouse, and rest room facilities.

4. A meeting at the park was arranged with Mr. Bruce Osgood and Mr. Greg Shute of the Belfast Recreation Department. This meeting, as well as informal discussions with area residents and park users indicated that the park area is heavily used at all times although no official attendance figures are available because there is no charge for use of the park facilities or for parking.

5. A 4:00 p.m. meeting was held at Belfast City Hall with Ms. Wilma Moses, the acting City Manager. The meeting involved an inspection of land-use maps as well as a discussion of the history of the Belfast City Park area. Ms. Moses indicated that the town had not encouraged swimming at the beach in recent years due to a pollution problem which has since been cleared up. Also discussed was a plan for the construction of a seawall at Belfast City Park by the Maine National Guard. Both the erosion problem and the seawall plan are being investigated further.

6. Messrs. Carrigan and Mancini stayed overnight in Belfast and continued the site inspection in the morning of August 7. Observations at low tide revealed a gently sloping beach consisting of medium to coarse grained sand and many rocky areas, especially close to the backshore embankment.

7. Impact/Import on NED: Local officials estimate the average rate of erosion at Belfast City Park to be 2.0 feet per year. This is the only salt-water park in the Belfast area and the shoreline is deteriorating rapidly. The local officials were very helpful and are willing to cooperate fully with the Corps.

Carrigan
CARRIGAN

cc: Coastal Dev. Br.
Reading File
Planning Div. File

DA FORM AUG 80 2496 PREVIOUS EDITIONS WILL BE USED

Mr. Barrows/mc/554

NEDPL-C

19 OCT 1981

Mr. Fred T. Breslin
City Manager
City of Belfast
Belfast, ME 04915

Dear Mr. Breslin:

Inclosed for your review and comments are six draft copies of the Belfast City Park Beach Reconnaissance Report for Small Beach Erosion Control Improvements. The study was initiated by a formal request from you in a letter dated 20 November 1980 and was pursued under the authority of Section 103 of the 1962 River and Harbor Act.

It should be noted that a reconnaissance report is a preliminary investigation to assess the feasibility of studying a proposed project in greater detail.

Upon completion of your review, we will forward the report to the Office of the Chief of Engineers in Washington for final review and approval. Should it be approved, we will initiate work on the Detailed Project Report upon the availability of funds. At that time, my staff will seek assistance from the city in our development of a comprehensive plan of improvement.

Should you have any questions, please feel free to contact me at (617) 894-2400, extension 220. Mr. Bruha of my staff coordinated the investigation. Should your staff desire additional information, he can be reached at extension 554.

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

cc: Executive Office
Coastal Dev Br
Reading File
Plng Div File

CITY OF BELFAST, MAINE 04915

FRED T. BRESLIN
City Manager

26 October 1981

Col C. F. Edgar III
N.E. Division
Corps of Engineers
424 Trapelo Road
Waltham, Mass 02254

Dear Col. Edgar,

We have received the draft of the Belfast City Park Beach Reconnaissance Report for Small Beach Erosion Control Improvements forwarded under your cover letter dated 19 October 1981.

I concur with the findings contained therein, and I would respectfully request that the Corps of Engineers proceed with stage 2 of the study.

Very truly yours,

Fred T. Breslin

Fred T. Breslin
City Manager

FTB/vmt
cc: Thomas Bruha
City Council
City Engineer
Norris Braley

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:
NEDPL-C

3 November 1981

SUBJECT: Belfast City Park Beach, Belfast, Maine, Beach Erosion Control Reconnaissance Report

CDR USACE (DAEN-CWP-E)
WASH, DC 20314

1. Inclosed are five copies of the Beach Erosion Control Reconnaissance Report for Belfast City Park Beach, Belfast, Maine. The report was prepared under the authority of Section 103 of the River and Harbor Act of 1962, as amended. It recommends that an improvement project for Belfast City Park Beach in the interest of beach erosion control is economically justified, environmentally acceptable, and satisfies the necessary requirements for a stable shoreline based on our engineering requirements. The city of Belfast has indicated in a letter dated 26 October 1981, inclosed in the Reconnaissance Report, that they concur with the findings as presented in the report and that we proceed with the Detailed Project Report (DPR).

2. Your office is currently in the process of evaluating two other small beach erosion control project reconnaissance reports: Bradley Rock and Sea Bluff Beaches, West Haven, Connecticut; and Conimicut Point Beach, Warwick, Rhode Island. Based on our manpower capability, the priority order for DPR initiation is Bradley Rock and Sea Bluff Beaches, Conimicut Point Beach, and Belfast City Park Beach, Belfast, Maine.

3. Based on the above priorities, the Bradley Rock and Sea Bluff Beaches and Conimicut Point Beach DPR's could be started in FY 1982 subject to the availability of funds. Belfast City Park Beach would be initiated in FY 1983 based on current schedules. It is estimated that $45,000 could be utilized in FY 1983 for initiation of the DPR. The final report would be ready for submission to OCE for final approval by September 1985 if afforded FY 83-84-85 funding.

4. It is requested that 96 x 3122 Construction General Code 902-420 funds in the amount of $7,500 be provided at this time for expenditures as reimbursement to date. A Project Cost Schedule showing current capability has been inclosed.

2 Incl
as

C. E. EDGAR, III
Colonel, Corps of Engineers
Commanding

DAEN-CWP-E (3 Nov 81) 1st Ind
SUBJECT: Belfast City Park Beach, Belfast, Maine, Beach Erosion Control Reconnaissance Report

HQ, U.S. Army Corps of Engineers, Washington, D.C. 20314 7 JAN 1982

TO: Commander, US Army Corps of Engineers Division, New England

1. We approve the subject report as the basis for preparation of a detailed project report pursuant to the continuing authority provided by Section 103 of the 1962 River and Harbor Act, as amended.

2. We no longer have regulations regarding minimum area per bather or turnover rates. Sufficient documentation and rationale should be presented to verify local estimates of beach visitation and the without project condition.

3. Your request for funding for reimbursement is being handled by separate communication.

FOR THE COMMANDER:

wd all incl

L. H. BLAKEY
Chief, Planning Division
Directorate of Civil Works

NEDPL-C Trip Report - South End and Breakwater Beaches, Rockland, ME
Belfast City Park Beach, Belfast, ME

MEMORANDUM FOR THE RECORD FROM: Project Manager DATE: 26 November 1982
Mr. Doucakis/559/cer

1. From 5 through 7 October 1982, Cathy LeBlanc and the undersigned visited Belfast and Rockland, Maine to initiate the Detailed Project Report at Belfast and the reconnaissance reports at South End and Breakwater Beaches.

2. Field measurements and photographs were taken at Belfast City Park Beach. The beach area is rocky with little dry beach area above mean high water. The embankment at the backshore area is scoured and continued erosion would eventually harm the park. We met with Mr. David Maynard, the City Manager at Belfast and explained the study process. Mr. Maynard will be kept informed of the project and the alternative plans of improvement.

3. South End and Breakwater Beaches are also badly eroded, have little dry beach space above new high water, and have scoured backshore embankments. South End Beach has a few small rocks along the shore and a low ledge outcrop. Breakwater Beach has a very rocky foreshore area and ledge outcrop on the south side of the beach area. Parking is limited, although additional parking could be provided for or other means could be used to get people to the beach. We had an informative meeting with Mr. Harold Parks, the Rockland City Manager, who gave us information helpful to initiate the reconnaissance reports.

4. Import/Impact on NED. The trip was useful in gathering information to initiate the reconnaissance reports at Rockland and proceed with the Detailed Project Report at Belfast. Both city managers were favorable to the Corps studies because of the need for saltwater beach facilities. Plans of improvement will be developed for these three beaches.

cc:
CDB (2)

JAMES G. DOUCAKIS
Project Manager

TIME & TIDE
RC&D
Resource Conservation & Development Project

U S ROUTE 1 WALDOBORO, MAINE 04572 TEL 207-832-5348

MAINE

April 4, 1983

Jim Doucakis, Project Manager
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02154

Dear Mr. Doucakis:

Thank you very much for a copy of the Reconnaissance Report for Belfast City Park Beach.

I couldn't find the Rockland, Maine studies in the material you sent. Would you send me a copy of that study, please.

Looking forward to hearing from you.

Sincerely,

Norris D Braley

Norris D. Braley
RC&D Coordinator

Trip Report: Belfast City Park Beach, Belfast, Maine

NEDPL-C

Commander
THRU: Channels

James G. Doucakis
Project Manager

11 July 1983
DOUCAKIS/lc/559

1. On 29 June 1983, the undersigned traveled to Belfast, Maine with Maureen Walsh and Cynthia Regis of Planning Division to meet with local officials to discuss Belfast City Park Beach.

2. Prior to the meeting, we toured the beach and park. The beach is scoured and rocky with continuing erosion. Observations were inconclusive as to the direction of littoral drift. The backshore park facilities are very well maintained and in good condition.

3. Present at the meeting for the city of Belfast was David Maynard, the City Manager, and Sherry Nemmers of the City Manager's office. Norris Braley of the Time and Tide, Resource Conservation and Development Project also attended the meeting.

4. Discussed at the meeting was future plans for improving and upgrading the park and waterfront area, which may attract more industry to the Belfast area. The beach is one of the few in the area that people can utilize. Mr. Maynard explained the city's future plans and development projects underway. Mr. Braley explained that the Soil Conservation Service has plans to improve the backshore park. Ms. Regis briefly spoke with the city assessor to obtain the tax rate on the waterfront property.

5. On 30 June 1983, we traveled to Rockland, Maine to observe South End and Breakwater Beaches. The reconnaissance reports for these two beaches will be completed shortly.

6. Import/Impact on NED:

The trip was helpful in gathering necessary information with local officials at Belfast. Frequent contact will be maintained with the local officials until completion of the DPR.

JAMES G. DOUCAKIS
Project Manager

cc:
Mr. Doucakis
Ms. Walsh
Ms. Regis
Plan Div Files

Mr. Wilson/mm/140

July 21, 1983

Planning Division
Impact Analysis Branch

Mr. Earle G. Shettleworth
Maine Historic Preservation Commission
55 Capitol Street
Augusta, Maine 04333

Dear Mr. Shettleworth:

Pursuant to a telephone conversation between Mr. John S. Wilson, our Division Archaeologist, and Dr. Speiss, of your staff, we enclose a map illustrating the area of proposed beach restoration at City Park in Belfast. The beach is heavily eroded in this area, and Dr. Speiss informs us that significant archaeological resources are very unlikely to be present. The proposed project includes addition of sand to restore the beach, and possible construction of one or more groins.

Due to the heavily eroded nature of the project area we believe that the proposed project will have "no effect" upon significant prehistoric or historic resources. We would appreciate your confirmation of this determination for inclusion in the Feasibility Report, which is now being written.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

cc: Mr. Wilson
Mr. Horowitz
Mr. Doucakis (CDB)
Plng Div File
Reading File

MAINE HISTORIC PRESERVATION COMMISSION
55 Capitol Street
Augusta, Maine 04333

Earle G. Shettleworth, Jr.
Director

Telephone:
207-289-2133

August 1, 1983

Mr. Joseph Ignazio
Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

re: City of Belfast, beach restoration

Dear Mr. Ignazio:

My staff archaeologist had fieldchecked the area of proposed beach restoration last year. The project area is indeed heavily eroded, and lacking in archaeological or historic sites.

I find that this project will have no effect upon any structure or site of historic, architectural, or archaeological significance as defined by the National Historic Preservation Act of 1966.

If I can be of further assistance concerning this matter, please do not hesitate to let me know.

Sincerely,

Earle G. Shettleworth, Jr.
State Historic Preservation Officer

EGS/slm

SPENCER APOLLONIO, COMMISSIONER

AREA CODE (207)
289-2291

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
STATE HOUSE — STATION 21
AUGUSTA, MAINE 04333

11 October 1983

Mr. Joseph Horowitz
Impact Analysis Branch
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Re: Small Beach Eorsion Control Project
Belfast (Maine) City Park

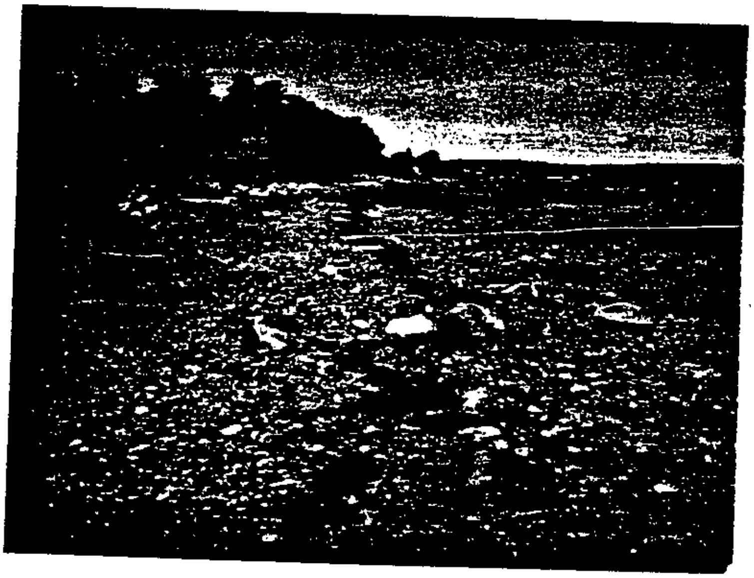
Dear Mr. Horowitz:

The area under study for beach creation varies in the nature of surface material, both from the bank at high water level to the low water line and along the 700 foot frontage of City Park. There is coarse and fine sand among the cobble in the eastern portion of the shore; in the center portion there is less cobble and gravel is predominant; westward the shore is gravel with small cobble.

Soft clams,Mya arenaria, are present in the sand among the scattered cobble from a level one foot or so above mean sea level to low water in the eastern portion. Clams are present near mean sea level in a part of the central portion that retains water during the low water period. Shells of clams in gravel from mid-tide to mean low water level in the central portion indicate that it is soft clam habitat that is not populated at the present. Possibly due to the relatively high recreational use of the area, there is no upper beach vegetation that would be expected ordinarily in sand and gravel on a similar shore.

It is not clear due to the preliminary nature of project design development, exactly where groins would be placed, how many there would be or how much of the intertidal area would be taken by the structures. Further, it is not clear where the toe of the slope for the 50 foot berm would be on the existing beach.

A line approximately 50 feet from the normal high-high tide level, or toe of the present bank and parallel to the shore is very close to the upper extent of normal clam, Mya arenaria, habitat. There is presently a scattered population of soft clams in the project area, primarily in the eastern portion and the section that retains water in the central portion. The City of Belfast passed an ordinance ten years ago to manage the soft clam resources and control harvesting in cooperation with four surrounding towns. A survey of the resource was proposed but apparently none was made. Clam harvesting is now prohibited due to local sources of pollution. As pollution abatement activities continue, the level of pollution may be reduced in the next two decades to levels that would permit harvesting.



SMALL BEACH EROSION CONTROL PROJECT
BELFAST CITY PARK BEACH
BELFAST, MAINE

The berm area is presently covered with gravel grading to cobble and approaches the softshell clam, *Mya arenaria*, habitat on its seaward edge.

Rapid fill of material over clam habitat can destroy the resident population. An accretion of upland sand on a shore where other conditions are favorable has in several cases according to anecdotal evidence encouraged recruitment of soft clam populations. Thus, a deposit of some sand in the upper portion of the beach would not necessarily be harmful for potential soft clam production. Some attempt should be made to avoid rapid displacement of the sand to the lower portions of the beach.

A typical stone armored groin from high water level to low water level would permanently destroy one quarter acre of potentially productive clam habitat. A groin of piling and plank or steel sheet would convert relatively little clam habitat and would be more appropriate on a shore with unique hydrography and little is known about sand sources along the shore.

Clearly, if the hydrography would permit sand to be retained on the shore there would be sand there now rather than the relatively coarse gravel.

Sincerely,

WALTER S. FOSTER
Marine Resources Scientist

WSF/dh

CC: Fred Benson
Norris Braley
James Doucakis

NEDPL-C 16 November 1983

MEMORANDUM FOR RECORD

SUBJECT: Belfast City Park Beach, Belfast, ME

1. On 20 Sep 83, Joseph Horowitz and the undersigned traveled to Belfast, Maine to meet with Mr. Fred Benson of the U.S. Fish and Wildlife Service and Mr. Walter Foster of the State of Maine Department of Marine Resources to discuss the subject beach.

2. The meeting commenced at approximately 3:15 p.m. The four of us walked the beach, talking about the proposed project alternatives and where the project limits were. Mr. Benson and Mr. Foster were digging for clams, at randomly selected sites along the beach. Their findings of living clams were very minimal (approximately five clams), as most of the findings consisted of dead clams or clam shells.

3. The meeting ended at 3:45 p.m. Mr. Foster and Mr. Benson will submit their findings and thoughts about the project to us in the near future.

4. Import/Impact on NED. It is hopeful that a small finding of clams will not be detrimental to a sand nourishment project at Belfast City Park Beach.

James G. Doucakis

JAMES G. DOUCAKIS
Project Manager

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

DEC 5 1983

Colonel Carl B. Sciple
Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This planning aid letter is intended to aid your study planning efforts for the development of beach erosion control measures at Belfast City Park Beach, Belfast, Maine. It has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

Belfast City Park Beach is the foreshore area of Belfast City Park, a city-owned recreational area of about 28 acres. There is essentially no dry beach area at mean high water along the 700 feet of park shorefront. This shorefront is subject to severe erosion during storm events resulting in a progressive loss of the backshore area. This backshore area drops nearly vertically, 5 to 10 feet, to the intertidal zone. We understand that your preliminary plans for improvement include beach widening, to a level berm width of 50 feet, by the direct placement of sandfill along approximately 700 feet of shoreline, without or with groin structures at various locations.

A field investigation of the project area was conducted on September 20, 1983, by personnel of the Maine Department of Marine Resources, the Corps, and this Service. The intertidal area is relatively flat and dominated by cobble and gravel. While there is both coarse and fine sand among the cobble and gravel it is not a predominate feature of this beach. Barnacles, periwinkles and rockweed were noted on the larger cobble and shells of blue mussels and soft clams were noted throughout most of the area.

A number of test pits were dug at random throughout the intertidal area to determine the extent of the soft clam resource. The western portion of the beach yielded some clam shells but no live clams. In the central portion soft clams were found near the mean low water line, however, many shells were found up to about mid-tide level. The eastern portion of the beach yielded the most soft clams, especially in the area 1 to 2 feet above mean low water level. Based on this preliminary survey, the area supports a modest population of soft clams, especially in the eastern and central portions at the lower tidal elevations. However, the presence of shells in many of the test pits suggests soft clam habitat that is currently unoccupied and that in the past the area supported a much larger soft clam population. The area is currently closed to the harvesting of clams due to local sources of pollution.

The direct placement of sandfill on the upper portion of the beach, to create a 50-foot wide level berm, would destroy some benthic organisms and prevent their reestablishment. However, the side slope and toe of this sandfill would most likely extend into soft clam habitat resulting in a loss of habitat and destruction of the resident population. This loss would be mitigated to some extent by the eventual recruitment of soft clams along the toe of the sandfill.

Placement of groins on the upper portion of the beach would have no significant impact upon resources of that area. Extension of these groins to the lower elevations of the beach would destroy a portion of the soft clam habitat.

Another potential for adverse impact is the migration of a large amount of sand from the new beach to the lower tidal area or to other sensitive areas in Belfast Bay.

The potential loss of soft clam habitat could be avoided by carefully sizing the dimensions of the sandfill so that the berm and sideslope do not infringe upon this habitat. The groins, especially at the lower elevations, could be set on pilings to avoid destruction of soft clam habitat. These two measures should be fully investigated during the planning process.

In order to more accurately assess the impacts of alternative project plans, the following information will need to be developed during the beach erosion control planning process: (1) an analysis of the potential migration of sand from the beach to other areas, and (2) refined estimates of the dimensions of the sandfill and groins.

We would be pleased to assist you in the various stages of project planning and we will report on the potential impacts of your selected plan.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Field Office

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT		
NEDPL-C	Maine Field Trip		
TO ~~Commander~~ THRU: Channels	FROM Project Manager	DATE 30 April 1984 Mr. Doucakis/559/cer	CMT 1

1. On Tuesday 24 Apr 84 Thomas Bruha and the undersigned visited Mr. Richard Cahill, Town Manager of Kennebunk, ME in Kennebunk Town Hall. The main problem seems to be that the coas road in Kennebunk may be in danger of eroding, which is a Sec. 14 study. There could be a potential beach project in the area depending upon the town's priorities.

2. We continued to Augusta to meet with Federal, state, and local officials (see attached list) concerning Belfast City Park Beach. The undersigned explained the coastal processes o the area, outlined the considered plans, and answered questions. There will be a clam survey on the beach sometime in June to determine the potential habitat.

3. A meeting was held on 26 Apr 84 with Rockland City Manager Harold Parks and Fourtin Powel of the Eastern Mid Coast Planning Commission on South End and Breakwater Beaches. I explaine the regional economic analysis that was done on the area that determined South End was positive and Breakwater was negative at this time. If conditions should change at Breakwater Beach, we would reopen the study.

4. Import/Impact on NED: The meeting at Augusta was helpful in coordinating with other officials interested in the project. We gathered historical and other information in Belfast t help us with the study. We are proceeding with the study and will have a clam survey at the beach in June.

Incl as

JAMES G. DOUCAKIS
Project Manager

CF:
Mr. Horowitz
CDB (2)
Plng. Div. Files

DA FORM AUG 60 2496 PREVIOUS EDITIONS WILL BE USED

LIST OF ATTENDEES AT AUGUSTA, MAINE - 24 APRIL 1984

Name	Organization
Thomas C. Bruha	New England Division
James G. Doucakis	New England Division
Fred Benson	U.S. Fish and Wildlife Service
Norris Braley	Time and Tide RC and D
Chris Mantzaris	National Marine Fisheries Serv. - Gloucester, MA
Don Witherill	Maine Department of Environmental Protection
M. Peter Holmes	U.S. EPA Region I
Walter S. Foster	Maine Department of Marine Fisheries
David A. Maynard	Belfast City Manager

July 9, 1984

Planning Division
Impact Analysis Branch

Mr. William Butler
Mailcode WR/WQ/PS
Chief, Planning and Standards Section
U.S. Environmental Protection Agency, Region I
JFK Building
Boston, MA 02203

Dear Mr. Butler:

We have been coordinating with Mr. Peter Holmes of your staff concerning our Section 103 study of Belfast City Park Beach, Belfast, Maine.

On July 12 - 13, a clam survey is scheduled to take place at the beach, to be performed by the joint interested agencies. We request the participation of Mr. Holmes to assist us with this survey.

If you have any questions, please feel free to call me at FTS 839-7508. Messrs. Joeseph Horowitz and Jim Doucakis of my staff are coordinating the plans for the survey and may be reached at FTS 839-7518 and 839-7559, respectively.

Sincerely yours,

JOSEPH L. IGNAZIO
Chief, Planning Division

cc:
Mr. Horowitz
Mr. Bellmer
Mr. Pronovost
Mr. Smith - 114 S
Mr. Doucakis - 114 S
Mr. Bruha - 114 S
Plng Div Files

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is TAGO.

REFERENCE OR OFFICE SYMBOL	SUBJECT
NEDPL-C	Trip Reports Belfast City Park Beach, Belfast, Maine

TO Commander
THRU: Channels

FROM Project Manager

DATE 25 July 1984
Mr. Doucakis/559/ap

CMT 1

1. On 12 July 1984, Ernest Waterman and the undersigned traveled to Belfast, Maine to coordinate a clam habitat survey at Belfast City Park Beach with personnel from other agencies (see attached memo for further details).

2. Waiting for us upon our arrival at the beach were WLBZ-TV Channel 2 in Bangor, Maine, members of the local press and a small turnout of area citizens concerning our project. After a short interview on television and radio, we proceeded with the clam survey.

3. Preliminary indications are that Mr. Holmes and Ms. Mello are not in opposition to our proposed project of sandfill with two terminal groin structures at the northern and southern limits of the beach, as long as we move the northern groin structure. Mr. Benson will comment when he receives our draft detailed project report and Mr. Foster will reply at a later date, although he is currently noncommittal and evasive as to what his thoughts on the project are.

4. On 17 July 1984, Cathy LeBlanc and the undersigned returned to Belfast for an evening meeting with the City Council. The undersigned explained the study process, how the selected plan was arrived at and then fielded questions from the City Council, Mayor, press and audience. The presentation lasted approximately 90 minutes.

5. Import/Impact on NED. The currently existing small population of clams found at Belfast City Park Beach is not considered a significant resource. However, the clam habitat involved is of some, though not significant concern to resource agencies. We expect that moving the northern groin away from the culvert will serve the secondary purpose of satisfying the agencies as it also moves the groin off of the area which all have expressed as representing habitat worth preserving. Our night meeting to the public was helpful in explaining our study process and future beach plans. The attendees seemed pleased with the study and voiced no opposition to the project.

JAMES G. DOUCAKIS
Project Manager

Incl
As stated

cc: Mr. Smith
Mr. Doucakis
Mr. Pronovost
Mr. Horowitz
Plan Div Files

DA FORM 2496 PREVIOUS EDITIONS WILL BE USED

NEDPL-C 25 July 1984

MEMORANDUM FOR RECORD

SUBJECT: Belfast City Park

1. Date of Trip: 12 and 13 July 1984

2. Place: Belfast City Park, Belfast, Maine

3. List of Participants:

Fred Benson, U.S. Fish & Wildlife Service
Walter Foster, Maine Dept. of Marine Resources
Peter Holmes, Environmental Protection Agency
Sue Mello, National Marine Fisheries Service

NED

Jim Doucakis, Planning, CDB
Ernest Waterman, Planning, IAB

4. Report:

The purpose of this trip was to determine if a significant clam population exists in the project area which will be adversely affected (thru burial) by beach nourishment operations, also to determine if the change in substate conditions after nourishment discourage or encourage repopulation of the project area.

7/12/84 - Party met at beach at 2:30 p.m. Sampling took place on 8 transects spaced 100 feet apart. Sampling stations on each transect were placed at 50 ft. intervals. A total of 25 stations were sampled. At each station a 2 ft^2 area was sampled to a depth of approximately 4". 12 Stratified sampling stations were also established along a transient pool formed by a ridge and runnel system migrating up the beach face. These stations were spaced at 20 ft. intervals and followed the approx. centerline of the pool. The pool width was measured at every other station to delineate the extent of this wet habitat.

7/13/84 - 8:30 to 9:30 a.m. a Meeting was held to discuss the results of the previous day's fieldwork. It was felt by the other agency representatives that three minor clam populations exist: one at the proposed northern groin, one at the center of the project area (transient) and one just south of the proposed southern groin, (This is partially based upon a previous clam survey.) Walter Foster suggested that the northern groin be moved to avoid impacting the northerly clam population, believed to be present. This would require moving the groin approximately 80 feet contracting the overall project length from 600 ft. down to 520 ft. This would, however, have the additional, beneficial effect of placing an existing storm drain culvert outside of the project area. It was agreed that using coarse, well graded sand for beach nourishment would enhance the existing habitat (improved substrate conditions). Concern was expressed over the possible negative effect of future periodic renourishment repeatedly impacting clam populations thru burial. It was pointed out that seeding a clam population after beach nourishment operations cease would not only minimize environmental impacts but would actually represent an environmental enhancement. Some concern was also expressed about the possibility of erosion just outside the project area caused by the groins. The extremely coarse nature of the existing material (gravelly sand w/numerous cobbles and boulders) makes such erosional problems highly unlikely.

ERNEST WATERMAN/JAMES G. DOUCAKIS

Incls: Clam survey data sheet, plan of clam survey

cc: Mr. Waterman
Mr. Doucakis (CDB)
Env. Res. Sec. Files (113 N)
Plng Div. File
Mr. Horowitz

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Services Division
Habitat Protection Branch
14 Elm Street
Gloucester, MA 01930

July 26, 1984

Mr. Joseph Ignazio
Chief, Planning Division
Impact Analysis Branch
Dept. of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Ignazio:

This in reference to the proposed Belfast, Maine beach creation project.

A soft shell clam (Mya arenaria) population survey was conducted by state and federal personnel on July 12, 1984. The results of that survey indicate that the the proposed placement of the northern groin is within a currently utilized shellfish area. Additionally, placement of the groin as proposed would enclose an existing stormwater outfall within the confines of the beach area, exacerbating erosion of placed sand. Therefore, we recommend that the northern groin be placed approximately 80' southward of the current proposal to conserve soft shell clam habitat and to exclude the stormwater outfall from the beach area. Additionally, we recommend that the Corps consider seeding the created beach with clams as a mitigation measure.

Sincerely

Bruce E. Higgins
Acting Branch Chief

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J. F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

July 26, 1984

Joseph Horowitz, Ph.D.
Environmental Resource Specialist
Impact Analysis Branch
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Dr. Horowitz:

This letter refers to the proposed establishment of a recreational beach in Belfast, Maine. Your agency proposes to create a beach by placing sand on a substrate that is primarily composed of cobble, rocks, and sandy clay. The sand will be held in place by the use of a groin at each end of the beach.

On July 12, 1984, an ecologist from our agency participated in a joint interagency on site shellfish survey to determine both the quantity of the existing shellfish population and the quality of the substrate for supporting shellfish and other marine organisms.

Results of the survey indicate that there is a viable shellfish resource in the northern portion of the proposed beach and groin location. There are also sporadic but random locations of shellfish throughout the remainder of the proposed beach site. Therefore, we recommend that the northern groin be move approximately 80 feet to the south on the other side of the existing storm water outfall. This relocation of the groin will protect the few naturally occuring viable shellfish resources in the area.

Thank you for the opportunity to participate in the joint shellfish survey. Such interagency participation is an example of state and federal government working together in the publics interest.

Please keep us advises of the progress of this project by contacting Mr. Melvin P. Holmes at (617) 223-3907.

Sincerely yours,

William J Butler

William J. Butler
Chief, Planning & Standards Section

SPENCER APOLLONIO, COMMISSIONER

AREA CODE (207)
289-2291

STATE OF MAINE
DEPARTMENT OF MARINE RESOURCES
STATE HOUSE — STATION 21
AUGUSTA, MAINE 04333

August 15, 1984

Mr. Joseph Ignazio
Chief, Planning Division
Impact Analysis Branch
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Re: Belfast (ME) City Park beach creation

Dear Mr. Ignazio:

The proposed beach development involves two solid-fill groins and a gravel-sand berm-beach. The nature of the beach at present is of mixed substrate of varying quality as soft shell clam (Mya) habitat.

The central portion, extending approximately 400 feet southeast along the beach from a proposed (August 1984) northern groin, is well-drained coarse sand grading to fine gravel and on the upper levels, near mean high water, cobble. In general, this area is a marginal clam habitat that is sparsely populated; two of twelve (16%) stations sampled for clams in a grid covering the area, contained clams. Exceptions to this are a drainage stream bed and a crescent-shaped moist area about 150 feet from the northern groin. The tenth-acre moist area is formed by a bar or dune-like sand ridge that causes water to be retained as the tide ebbs. Its location has moved over the years and it may be considered ephemeral. Presently the area contains one of the most densly populated clam populations in the project area.

The beach becomes clam habitat of better quality north of the northern groin and 435 feet south of the existing concrete drainage culvert; population densities are tenfold that of the central portion. Although the area is closed to shellfish harvest due to pollution, it is evident that the two areas are continuously harvested (poached).

The southern groin is located about 150 feet into the southern section of higher grade clam habitat. It will permanently fill a portion of this habitat the width of the groin and from mean low water 100 feet shoreward.

Sand or gravel fill between the groins could be reinhabited by soft clams either through natural recruitment or planted with small clams. The area so repopulated would be from one foot above mean sea level to mean low water. Since the slope of the proposed beach is greater than the existing beach, it diminishes the potential clam habitat to the degree that this area is diminished.

If the fill material is not stable, not capable of being retained on the beach, it is unlikely that clams recruited to the beach will be able to reach maturity or harvestable size which may take four or more years. Renourishment, sand added to the beach, if planned as a routine measure, could smother recruited clams in the beach area.

Sincerely,

Walter S. Foster
Wetlands Coordinator

State of Maine

DEPARTMENT OF MARINE RESOURCES

MEMORANDUM

Date August 17, 1984

To J. Horowitz, C of E; F. Benson, USFWS; S. Mello, NMFS; Peter Holmes, EPA

From Walter S. Foster WSF

Subject Belfast City Park clam survey of July 12, 1984

In the summary of the clam survey you will note several departures from the sketch map we used in our discussions of July 13. I am willing to discuss any questions with any interested party.

WSF/mw
Enc.

BEACH DEVELOPMENT, BELFAST CITY PARK
CLAM SURVEY, JULY 12, 1984

Purpose of the survey was to sample the area of the proposed Corps of Engineers beach construction to define soft clam habitat and population. Survey is based on Maine Department of Marine Resources clam survey methods.

Sample plots were located at fifty-foot intervals along parallel transects spaced 100 feet and perpendicular to the shore. The concrete park drainage outfall, about 100 feet from the northern border of the park is the point of reference for both transect spacing and sample intervals. Samples were approximately 0.2 square meter (155 sq in); one surveyor made plots 2 square feet in area (144 sq in). Each person sampling use a conventional clam digging hoe to search the plot area outlined.

Diagramatic Sample Grid for Clam Survey

					$(Center of culvert)		
				G	D	A	
	W	T	Q	N	H	E	B
Z Z'	X	U	R	O	I	F	C
	Y	V	S	P	J		

Plots W and J are located at an elevation in the intertidal zone above that normally inhabited by soft clams.
Plots Z and Z' were samples August 9, 1984; tide did not permit sampling at level of Y at that time.

Numbers and sizes of clams collected in normal grid pattern

Plot	A	B	C	D	E	F	G	H	I	J	N	O	P	L	Q	R	S	T	U	V	X	Y	Z	Z'
Size Range Millimeters																								
15-19																								
20-24					1	1																		
25-29	2					2			1															
30-34	2																1							
35-39	2	1																						
40-44																								
45-49																							2	
50-54																					1			
55-59						1																	1	
60-64																								1
65-69																							1	1
70-74																								1
Plot	A	B	C	D	E	F	G	H	I	J	N	O	P	L	Q	R	S	T	U	V	X	Y	Z	Z'

Size and number of clams in ephemeral area

Plot / Size Range Millimeters	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ	KK	LL
15-19				1		1			1			
20-24	1			2	1				1		1	
25-29	1	1				1					2	
30-34												
35-39			1	1							1	
40-44												
45-49												
50-54												
55-59												
60-64			1									
65-69				1								
70-74												
Plot	AA	BB	CC	DD	EE	FF	GG	HH	II	JJ	KK	LL

Northern productive clam habitat area

Plots	Clams	Concentration Bushels per acre	
A	6	20.171	
B	1	4.95	
C	0	0	
E	1	1.0414	
F	4	23.014	
Av.	12/sq meter	11.3 bu/a	9.8 hectoliters/hectare

Area: .63 acres Crop 7.1 bu.

Southern productive clam habitat area

Plots	Clams	Concentration Bushels per acre	
X	1	77.938	
Y	0	0	
Z	4	102.561	
Z'	3	13.753	
Av.	10/sq meter	48.5 bu/a	42.3 hectoliters/hectare

Area: .47 acres Crop 23 bu.

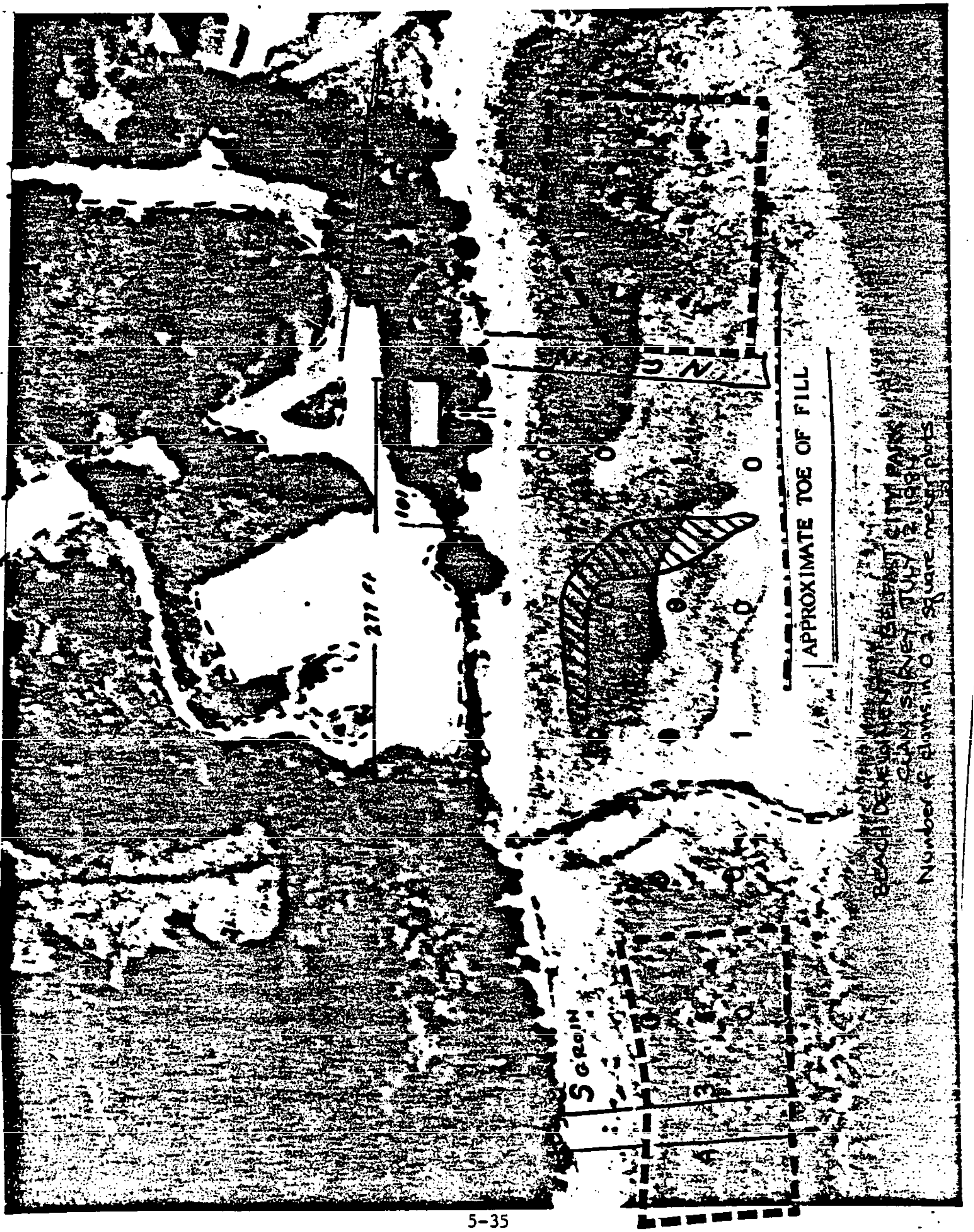
Ephemeral moist area summary

Plots	Clams		Concentration Bushels per acre	
12	21	Sum	100.299	
(9 with clams)				
Av.	9.5/sq meter		8.4 bu/a	7.3 hl/ha
Area: 0.1 acres			Crop 0.8 bu.	

The area was sampled at 20 foot intervals

Central sandy-gravel area exclusive of moist crescent

Plots	Clams	Concentration Bushels per acre	
13	2	5.893	
(2 with clams)			
Av.	0.77/sq meter	0.45 bu/a	0.39 hl/ha
Area: 1.17 acres		Crop 0.5 bu.	



APPROXIMATE TOE OF FILL
GROIN
277 ft

APPENDIX 6

CORRESPONDENCE RECEIVED AFTER ISSUANCE OF THE DRAFT DETAILED PROJECT REPORT, INCLUDING CZM CONSISTENCY CONCURRENCE AND WATER QUALITY CERTIFICATION

APPENDIX 6

TABLE OF CONTENTS

ITEM

SECTION

SECTION A

COMMENTS AND RESPONSES ON THE DRAFT DETAILED PROJECT REPORT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO ATTENTION OF

January 31, 1985

Planning Division
Coastal Development Branch

TO: Concerned Belfast City Park Beach Interests

The enclosed document summarizes the studies conducted to date by the New England Division, U.S. Army Corps of Engineers, for providing beach improvements for Belfast City Park Beach, Belfast , Maine, located on the northwestern end of Penobscot Bay. The Draft Detailed Project Report includes an Environmental Assessment, a Finding of No Significant Impact (FONSI), and a Section 404(b)(1) Evaluation. We are forwarding the reports for your review and request your comments on the concept of constructing a beach replenishment project with sandfill, two terminal groin structures, and rock revetment.

Several alternatives were analyzed to find the plan that best meets the present and future needs of the area. The result of this analysis is that the most feasible plan of improvement is the widening of Belfast City Park Beach by the direct placement of suitable sandfill along approximately 550 feet of shoreline and construction of two terminal groin structures to be located at the northern and southern limits of the study. The plan also includes 20 feet of rock revetment both north of the northern groin structure and south of the southern groin structure. The project will provide a width of approximately 112 feet of dry beach space above the mean high water line.

The attached report, Environmental Assessment, and FONSI and Section 404(b)(1) Evaluation will be open for public comment for a 45-day period ending 19 March 1985. Please direct all comments, before this date, to me at the following address:

Division Engineer
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02254-9149

Please feel free to contact me at 617-647-8220 if you have any questions. Mr. Thomas C. Bruha, of my staff, is the project manager; he can be reached at 617-647-8554.

Sincerely,

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

Enclosure

US Army Corps
of Engineers
New England Division

News Release

85-113	Sue Douglas
Release No.	Contact:
Upon Receipt	617-647-8264
For Release:	Phone:

424 Trapelo Road, Waltham, Massachusetts 02254

ENVIRONMENT

RIVER SYSTEMS

RECREATION

FLOOD CONTROL

NAVIGATION

SHORE PROTECTION

January 31, 1985

ENGINEERS RECOMMEND IMPROVEMENTS TO BELFAST CITY PARK BEACH

WALTHAM, Mass. — The U.S. Army Corps of Engineers' New England Division has recommended improvements for Belfast City Park Beach to control erosion. That finding is included in a report recently released by Colonel Carl B. Sciple, head of the Engineers in the region.

The recommended improvements include widening 550 feet of the existing beach to provide a useable width above the mean high water line of about 112 feet. In addition, two terminal groins, with rock revetment on the outer sides, would be constructed at the northern and southern limits of the beach to compartmentalize approximately 18,000 cubic yards of sand to be placed.

The Engineers estimate the improvement would cost about $363,000, of which the federal share would be $254,100 and the non-federal share $108,900.

Public comments are being sought on the recommendation until March 19, 1985. Copies of the report may be obtained from and comments should be forwarded to Colonel Sciple at the New England Division, U.S. Army Corps of Engineers, 424 Trapelo Road, Waltham, MA 02254-9149.

-30-

HOROWITZ/et/518

February 4, 1985

Planning Division
Impact Analysis Branch

Ms. Betsy Higgins
Mail Code GRER
Office of Government Relations
and Environmental Review
J.F.K. Federal Building
U.S. Environmental Protection Agency-Region I
Boston, Massachusetts 02203

Dear Ms. Higgins:

This letter is forwarding the enclosed Draft Detailed Project Report, Environmental Assessment, Finding of No Significant Impact and Section 404(b)(1) Evaluation for Belfast City Park Beach, Belfast, Maine. At this time we ask that you review the enclosed material relevant to your agency responsibilities, including those pertinent to Section 176 (c) and 309 of the Clean Air Act, as amended. Please forward any comments you have by March 19, 1985.

Should you have any questions or wish additional information, please contact Mr. Joseph Horowitz of my Planning Division, Impact Analysis Branch, at FTS 839-7518 or Mr. Thomas Bruha, the Project Manager, at FTS 839-7554.

Sincerely,

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

JGK

C/ENV RES SEC

CC:
Mr. Horowitz
Mr. Bellmer
Mr. Pronovost
Mr. Smith
Mr. Bruha
Plng Div Files
Reading File

C/IAB

C/PLNG DIV

DDE

DE

U.S. Department of Housing and Urban Development
Boston Regional Office, Region I
Bulfinch Building, 15 New Chardon Street
Boston, Massachusetts 02114

FEB 25 1985

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer
242 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

SUBJECT: Belfast City Park Beach - Belfast, Maine
Detailed Project Report and Environmental Assessment
Small Beach Erosion Control Project Review Draft

We have reviewed the review draft of the Project Report and have no comments to offer.

Sincerely,

Sheldon Gilbert

Sheldon Gilbert
Regional Environmental
Officer

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

No response required.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

FEB 2 6 1985

Colonel Carl B. Sciple
Division Engineer
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This is our Fish and Wildlife Report on the Belfast City Park Beach Erosion Control Project, Belfast, Maine. It has been prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended: 16 U.S.C. 661 et seq.).

Your Draft Detailed Project Report (DDPR) presents Plan 2 as the recommended plan for beach erosion control at Belfast City Park Beach. This plan consists of beach widening, to a level berm width of 50 feet, by the direct placement of suitable sandfill (18,000 cy) along 550 feet of shoreline and construction of terminal rock groins at the northern and southern end of the project. The plan also includes rock revetment along the backshore extending 20 feet north and south of the terminal groins. Neither the sandfill nor the groins would extend seaward of the mean low water line. Sandfill material would be coarse, clean, free of any harmful contaminants and composed of naturally occurring sand from a suitable upland site(s). Construction activities are scheduled to be completed during the period from 1 April to 30 June. Periodic sand nourishment would be necessary to maintain project dimensions and is estimated at 1,100 cy per year.

The 780-foot long by 275-foot wide intertidal area of Belfast City Park Beach is relatively flat and is comprised of medimum to coarse sand and gravel overlain by cobble with a scattering of boulders. This intertidal area supports a modest population of soft clams from about 1-foot above mean sea level to the mean low water line. Clam density is highest at the northern and southern ends of the beach and in a small moist empheral area in the central area of the beach. In accordance with the Fish and Wildlife Service Mitigation Policy, we consider the intertidal area of Belfast City Park Beach to be Resource Category 2 and 3.

We are pleased to note that the selected plan, Plan 2, results in a reduction of project dimensions as suggested in our Planning Aid Letter of December, 1983. Shortening the length of sandfill from 780 feet to 550 feet and not extending the toe of the sandfill below elevation - 2.6 feet NGVD (MLW at - 4.6 feet NGVD) will avoid destruction of much of the better clam habitat in the northern and southern sections of the existing beach as well as along the mean low water line.

The project documents acknowledge that the proposed project would still result in a loss of clam habitat, however, these losses will be mitigated. On page 5, the Environmental Assessment (EA) states that: "A preconstruction site survey will be conducted to determine the population densities of the soft clam at the beach. The beach will be reseeded at a ratio of 10:1 with seedlings, following construction." We agree that reseeding clams can be an effective mitigation technique and recommend that the following optional seeding rate be utilized for Belfast City Park Beach. The sandfill area should be reseeded with seedling clams from about 1-foot above mean sea level to the toe of the sandfill at the rate of 10 seedlings per square foot of area. We believe this seeding rate would be more effective in reestablishing the clam resource and could be accomplished without a significant increase in mitigation costs.

1.

On page 5, the EA also states that "A follow-up survey will be accomplished approximately one year later to evaluate the success of the seeding". We recommend that this statement be expanded to include reseeding efforts if the initial seeding fails to establish a clam population at least equal to the one destroyed by initial sandfill.

2.

On page 10, the DDPR states that: "Also to enable a more accurate determination of sand movement in and around the beach, a series of post construction surveys and monitoring program would be scheduled. This would assist in comparing and evaluating the effects of a better quality of sandfill material and the effect of groin construction on sand movement." We recommend that these post construction surveys and monitoring programs include an evaluation of the impacts of sand movement, especially after periodic renourishment, upon the soft clam resource. This would provide valuable information that could be utilized in the evaluation of similar projects in this geographic area.

3.

We conclude that in view of avoidance of much of the better clam habitat coupled with the proposed mitigation measures the recommended plan will not have a significant long term adverse impact upon fish and wildlife resources of the project area.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor
New England Field Office

U.S. FISH AND WILDLIFE SERVICE

We appreciate your interest in the project, and your suggestions concerning mitigation and monitoring. All of your suggestions (1, 2, and 3) will be incorporated into the project plans and will be implemented at the appropriate times.

Bruha

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J. F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

March 5, 1985

Colonel Carl B. Sciple
Division Engineer
New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

ATTN: Planning Division, Impact Analysis Branch

Dear Colonel Sciple:

In accordance with Section 176(c) and 309 of the Clean Air Act, and the National Environmental Policy Act, we have reviewed the Draft Detailed Project Report, the Draft Environmental Assessment/Environmental Finding of No Significant Impact, and Section 404(b)(1) Evaluation for the Belfast City Park Beach -- Small Beach Erosion Control Project, Belfast, Maine.

The selected plan has been found to be satisfactory from the standpoint of environmental quality health and welfare, within EPA's areas of jurisdiction and expertise. We appreciate the opportunities you have given EPA to provide advice during the development of this project. As a result of this coordinated effort, we believe an environmentally preferable plan that protects viable shellfish resources in the project area has been developed and selected for implementation.

Please send us two copies of the Final Belfast City Park Beach Detailed Project Report, Environmental Assessment/Environmental Finding of No Significant Impact, and Section 404(b)(1) Evaluation.

Sincerely yours,

Elizabeth A. Higgins

Elizabeth A. Higgins, Assistant Director
for Environmental Review
Office of Government Relations
and Environmental Review (RGR-2203)

cc: Joseph Horowitz, COE NED
Planning Division, Impact Analysis Branch
Thomas Bruha, Project Manager, COE NED

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 1 - HIGGINS

No response required.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Project Review
1500 Custom House
165 State Street
Boston Massachusetts 02109

IN REPLY REFER TO:

ER 85/250

March 13, 1985

Colonel Carl B. Sciple
Division Engineer
U.S Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This letter represents the Departmental comments on the draft Detailed Project Report and Environmental Assessment for beach erosion control at Belfast City Park Beach, Belfast, Maine.

The project documents acknowledge that the proposed project would result in a loss of soft clam habitat, however, these losses will be mitigated. We agree that reseeding clams can be an effective mitigation technique and recommend that the following optional seeding rate be utilized for Belfast City Park Beach. The sandfill area should be reseeded with seedling clams from about 1-foot above mean sea level to the toe of the sandfill at the rate of 10 seedlings per square foot of area. We believe this seeding rate would be more effective in reestablishing the clam resoource and could be accomplished without a significant increase in mitigation costs.

On page 5, the Environmental Assessment states that "A follow-up survey will be accomplished approximnately one year later to evaluate the success of the seeding." We recommend that this statement be expanded to include reseeding efforts if the initial seeding fails to establish a clam population at least equal to the one destroyed by initial sandfill. In addition, we recommend that the post construction surveys and monitoring programs include an evaluation of the impacts of sand movement, especially after periodic renourishment, upon the soft clam resource. This would provide valuable information that could be utilized in the evaluation of similar projects in this geographic area.

We conclude that the recommended plan will not have a significant long term adverse impact upon resources of concern to this Department.

Sincerely yours,

William Patterson

William Patterson
Regional Environmental Officer

MAR 15 1985

U.S. DEPARTMENT OF THE INTERIOR

See response to U.S. Fish and Wildlife Service letter.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J. F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

March 19, 1985

Carl B. Sciple, Colonel
Corps of Engineers
Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This letter refers to our 404(b)(1) review of the "Environmental Assessment and Finding of No Significant Impact for the establishment of the Belfast City Park Beach, Belfast, Maine".

Our agency has been actively involved with this project since its initial proposal. An ecologist from our agency participated in a joint interagency on site shellfish survey to determine both the quantity of the existing shellfish population and the quality of the substrate for supporting shellfish and other marine organisms.

Results of the survey indicated that there was a viable shellfish resource in the northern portion of the proposed beach and groin location. We requested that the northern groin be relocated to avoid impacting the shellfish in the area.

Plan 2- Sandfill and construction of two terminal groin structures at the northern and southern limits of the beach is the proposed plan to be implemented by the Corps of Engineers. Our agency does not object to this alternative since the northern groin was relocated to address our concerns for the shellfish located in this portion of beach. Also there is to be a 10:1 ratio reseeding of clams in the intertidal zone at the completion of the project. Further, our agency will be involved with the follow up biological survey to take place one year later.

Therefore, we do not anticipate any significant adverse environmental effect to occur from the implementation of this project as proposed in the Environmental Assessment.

Sincerely yours,

Eric P. Hall

for William J. Butler, Chief
Planning & Standards Section

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 1 - BUTLER

No response required.

STATE OF MAINE
EXECUTIVE DEPARTMENT
STATE PLANNING OFFICE

JOSEPH E. BRENNAN
GOVERNOR

RICHARD E. BARRINGER
DIRECTOR

March 29, 1985

Colonel Carl B. Sciple, Division Engineer
Dept. of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

RE: Intergovernmental Review
SAI: 85 0206 001
Environmental Assessment and FONSI for beach improvements at Belfast City Park Beach

Dear Colonel Sciple:

This is to certify that the above referenced notice underwent Intergovernmental Review in compliance with Federal Executive Order #12372 and State Executive Order 7 FY 83/84.

Sincerely,

Harold Kimball ns

Harold Kimball
Review Coordinator

HK/ns

184 STATE STREET, STATE HOUSE STATION 38, AUGUSTA, MAINE 04333 TEL. (207) 289-3261 or 3154

MAINE STATE PLANNING OFFICE - INTERGOVERNMENTAL REVIEW COORDINATOR

No response required.

CITY OF BELFAST, MAINE 04915

City Manager's Office
71 Church Street
Belfast, Maine 04915
(207) 338-3370

April 25, 1985

Colonel Carl B. Sipel
New England Division
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Re: City Park Beach Creation - Belfast, Me.

Dear Col. Sipel:

This letter is to constitute administrative approval of the proposed City PARK Beach Creation Project located in Belfast, Maine. The review draft of the project report has been distributed to the several boards and committees of the City and a copy placed on public review status in the City Office. No Board or Committee, including the City Council, has taken action against the project. As the time period for such action has fully elapsed, I am now able to indicate to you that the City of Belfast has given administrative approval to proceed to the next step in process.

When funding becomes available from the Corps, or some other federal/state source, the project will then need to come before the City Council for final project review (fiscal) and the appropriation of the local share of the fund requirement. The project is listed in the latest Capital Improvements Program for future funding.

At this point, I would like to thank you and all of your very able staff for the substantial time and effort allocated to this project and note that I am aware of the difficulties encountered and over come in making the project feasible for further consideration. The City of Belfast is a small community in a very rapidly developing area of the Maine Coast. The Corps has been exceptionally responsive in dealing with the changing needs of our area and we look forward to a continued good working relationship as other matters come to you in the near future.

Again, thank you and your staff.

Yours truly,

David A. Maynard

David A. Maynard
City Manager

DAM:dam

SECTION B

CZM CONSISTENCY CONCURRENCE AND WATER QUALITY CERTIFICATION

February 4, 1985

Planning Division
Impact Analysis Branch

HOROWITZ/et/518

Mr. Richard Barringer
Director
Maine State Planning Office
State House Station #38
Augusta, Maine 04333

Dear Mr. Barringer:

I have enclosed a copy of the report which summarizes the study conducted to date by the New England Division, U.S. Army Corps of Engineers, concerning beach improvements for Belfast City Park Beach, Belfast, Maine. This document is a Draft Detailed Project Report, including an Environmental Assessment, a Finding of No Significant Impact (FONSI), and a 404 (b)(1) Evaluation.

We have reviewed the eleven core laws of the State of Maine's Coastal Program in accordance with Section 307 of the Coastal Management Act of 1972. From this review, we have determined that this project is consistent with the intent and specifics of Maine's Coastal Program. We ask that you review this project and concur with our determination.

We would appreciate receiving your comments and recommendations by 19 March 1985 or preferably at such an earlier date as may be convenient. Please feel free to contact me at 617-647-8220 if you have any questions, or Mr. Joe Horowitz of my Planning Division, Impact Analysis Branch, at ~~FTS~~ 617-647-8518.

Sincerely,

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

C/ENV RES SE

C/IAB

C/PLNG DIV

DDE

Enclosure

cc:
Mr. Horowitz
Mr. Pronovost
Mr. Smith
Reading File
Mr. Bellmer
Mr. Bruha
Plng Div Files

6-B1

STATE OF MAINE
EXECUTIVE DEPARTMENT
STATE PLANNING OFFICE

JOSEPH E. BRENNAN
GOVERNOR

RICHARD E. BARRINGER
DIRECTOR

February 19, 1985

Colonel Carl B. Sciple
Division Engineer
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Colonel Sciple:

This responds to your letter dated February 4, 1985, concerning proposed beach improvements to Belfast City Park Beach.

In order to have sufficient information to review this activity for consistency with Maine's Coastal Program, we need a completed Water Quality Certification application for the project. I understand that your staff is preparing this application and will submit it shortly to the Maine Department of Environmental Protection. We shall be able to respond to your consistency determination within 45 days of receiving the application.

I would like to commend your staff, particularly Joe Horowitz, for the efforts they have taken to coordinate with State and local agencies on this project in its early planning. This will surely benefit the project and help to expedite its review.

If you have any questions, feel free to contact me or John DelVecchio. With very best wishes,

Sincerely,

Dick Barringer

Richard E. Barringer

REB:nv

184 STATE STREET, STATE HOUSE STATION 38, AUGUSTA, MAINE 04333 TEL. (207) 289-3261 or 3154

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF

March 11, 1985

Planning Division
Impact Analysis Branch

Mr. Henry Warren, Commissioner
Maine Department of Environmental Protection
State House Station 17
Augusta, Maine 04333

Dear Mr. Warren:

Enclosed please find an application for Water Quality Certification for the proposed beach improvement project at City Park, Belfast, Maine. Based on the anticipated impacts, this office is requesting that a Water Quality Certificate be issued for the proposed work. I have also enclosed a copy, for your use, of the Draft Detailed Project Report, Environmental Assessment, Finding of No Significant Impact and Section 404 (b)(1) Evaluation.

I would appreciate receiving your action on this application within 45 days of the date of this letter, or preferably at such an earlier date as may be convenient. Please feel free to contact me at 617-647-8220, if you have any questions, or Mr. Joe Horowitz of my Planning Division, Impact Analysis Branch, at 617-647-8518.

Sincerely,

Carl B. Sciple
Colonel, Corps of Engineers
Division Engineer

Enclosure

Maine Department of Environmental Protection
Bureau of Land Quality Control
State House
Augusta, Maine 04333
Telephone: 289-2111

Application No.________________
(To be filled in by DEP)

DATE STAMP
(To be filled in by DEP)

APPLICATION FOR

WATER QUALITY CERTIFICATION
(P.L. 92-500)

PLEASE TYPE OR PRINT

Name of Applicant: New England Division, U.S. Army Corps of Engineers

Address: 424 Trapelo Road, Waltham, MA 02254-9149

Telephone Number: (617) 647-8220

Local Contact or Agent (Name & Tel. No.): Tom Bruha, Project Manager, (617) 647-8554

LOCATION OF ACTIVITY

Street or Route No.: City Park Beach

Municipality or Township: Belfast

County: Waldo

By signing this application the applicant certifies that he has (1) published the public notice once in a newspaper circulated in the area where the project is located, (2) sent a copy of the notice form to the owners of property abutting the land upon which the project is located, (3) sent a copy of the public notice form to the chief municipal officer and chairman of the municipal planning board, and (4) sent a duplicate of this application to the municipal office.

DATE: March 11, 1985

Signature of Applicant

TITLE: Division Engineer
(If other than applicant, attach letter of agent authorization)

CHECK YOUR APPLICATION. BE SURE THAT ALL INFORMATION REQUESTED IS SUBMITTED, ALL QUESTIONS THAT ARE PERTINENT ARE ANSWERED AND THAT THE DIAGRAM IS COMPLETE AND SPECIFIC (BE SURE TO INCLUDE ALL DIMENSIONS).

IF ANY INFORMATION IS MISSING YOUR APPLICATION WILL BE RETURNED TO YOU.

(Revised 6/79)

Wetland Application Instructions

With this application the applicant must:

1. Obtain the appropriate USGS topographic map (available at most sporting goods, book, hardware, stationery stores, etc.). Indicate the location of your project on the map, and attach it to the application.

2. Provide one photograph of the wetland area involved.

3. Publish a copy of the Notice (last page of this application) in the legal notice section of a newspaper circulated in the area where the project is located.

4. Send a copy of the NOTICE form attached to this application to the owners of property abutting the land upon which the project is located. Their names and addresses can be obtained from town tax maps or local public officials.

   Set forth below the names of the abutting property owners:

NAME	ADDRESS
Priscilia Hardy	2 Mabelene Rd., Charleston, South Carolina 29418
Ruth Briggs	P.O. Box 233, Belfast, Maine 04915
Mary Perry	Fahey St., Belfast, Maine 04915
Mr. & Mrs. Roger Lothrop	Fahey St., Belfast, Maine 04915

5. Send a copy of this application, together with all exhibits, to the municipal offices. If the land does not lie within an organized municipality, the applicant shall send a copy of this application, together with exhibits, to the office of the County Commissioners. The applicant shall also send a copy of the NOTICE attached to this application to the Chairman of the Planning Board, if any, and the chief municipal officer, if any.

6. Attach copy of deed, lease, purchase agreement, or other legal document establishing title, right or interest of applicant in the site.

7. If the applicant is a corporation attach a certificate of good standing from the Secretary of State of Maine.

Check below any other permits required for the project. Indicate with an asterisk (*) those permits already obtained.

U.S. Army Corps of Engineers (Tidal Waters) ☐

Waste Discharge (DEP) ☐

Other (Explain) ☐ ______________________

WATER QUALITY

PROJECT SUMMARY—~~WETLANDS ACT~~ CERTIFICATION

TO BE FILLED IN BY DEP

Applicant: ______

City/Town: ______ **County:** ______

Name of Project: ______

Project No.: ______

1. Description of Project: Direct placement of clean coarse sandfill along approximately 550 feet of the existing beach, from the existing backshore embankment, seaward, a distance of 50 feet (berm-width) at a height of 15 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 245 feet. Also construction of two terminal groin structures of approximately 195 foot length to be located at the northern and southern limits of the sandfill. The plan also includes 20 feet of rock revetment along the backshore embankment both north of the northern groin structure and south of the southern groin structure.

2. Length of shoreline on the coastal wetland owned or controlled by the applicant..

   780 feet

3. Indicate nature of shoreline and tidal area (grassy, mud, rock, etc.)

   Rocky beach - cobble over coarse and fine sand and gravel.

4. Actual physical dimensions of project:

   For the purposes of this application wetlands is defined as all area seaward of the debris line left by normal storm flowage. Please refer all dimensions to this mark.

   Length out into wetland: 245 feet

   Width along shore: 550 feet

   Height: See item 1 above

5. Description of present use of the wetland: Recreational Beach used extensively by the general public.

6. Description of present use of the adjacent wetland: Adjacent shore is private property.

7. List equipment to be used in construction of the project: bulldozer or frontend loader and a crane to place the rock for the groins and the revetment.

8. If this project is part of a larger project describe below:

9. If ~~dredging or~~ filling indicate number of cubic yards: 18,000 c.y. of clean coarse sandfill and 4100 tons of rock

10. Indicate location for deposition of dredged material: Belfast City Park Beach, Belfast, ME

11. Is this project to be located within a coastal sand dune system? ☐ YES ☒ NO

If YES, what are the actual physical dimensions of the project that will involve the coastal sand dune system?

12. How far away is the ~~XXXXXXXX~~ mlw line from the farthest extension of the proposed project into the wetland? About 40 feet

13. Is this project associated with a commercial enterprise? (Please check one) ☐ YES ☒ NO

If you have checked YES you must contact the Bureau of Public Lands to negotiate a lease to use the public lands involved. Action will not be taken on your proposal by this Department until we receive a copy of the signed lease from the Bureau of Public Lands. They can be contacted at:

Bureau of Public Lands
Dept. of Conservation, Station 22
State House
Augusta, ME. 04333

Tel. 289-3061

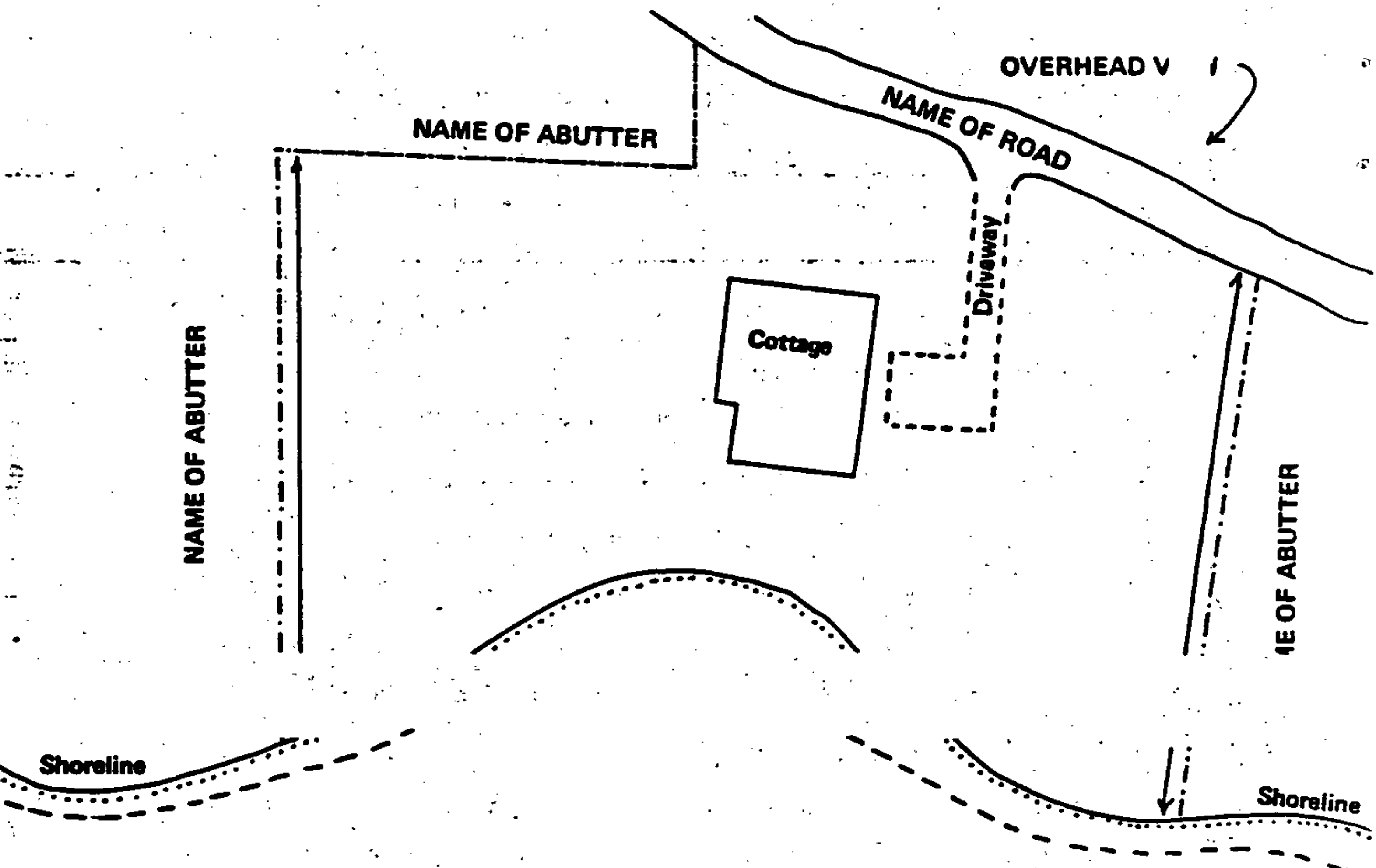
NOTE: A bulk sediment analysis of the dredged material indicating heavy metals and oil and grease may be necessary for projects involving dredging of large amounts in areas of known contamination.

See Attached Plan

Apr... Name... ... iption

Scale: ...

D. ... ters



...... High Water Mark

_____ Property Lines

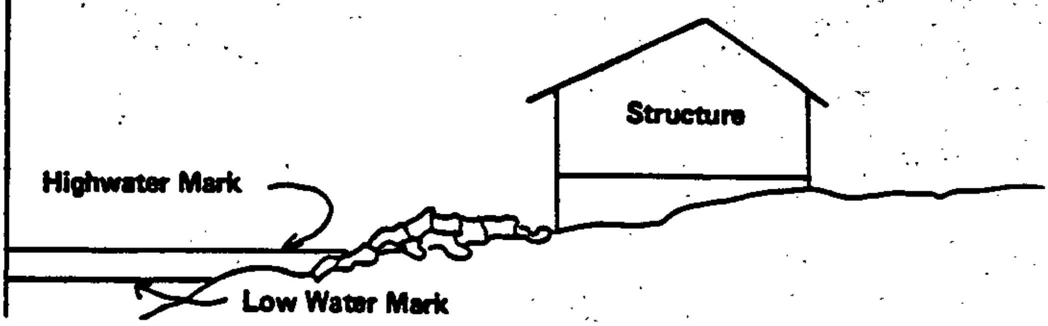
_____ Low Water Mark

Locate the Proppsed Project on Your Site Plan.

Information Required On Drawings

1. High Water Mark
2. Low Water Mark
3. Dimensions
4. Property Lines
5. Property Owners Names
6. Existing Structures
7. Location of Project

SIDE VIEW



See Attached Plan

Submit a scale drawing of the coastal wetland to be affected by the project, which shows the project in detail, the landowner's property boundary lines, the *low-water mark* and *high-water mark*. For your convenience, blank graph paper is attached. Applicants may submit larger drawings or blueprints but if they exceed 8½ X 11" eleven copies are required.

PLAN (OVERHEAD) VIEW

SIDE VIEW

NOTE: Use this form or one containing identical information

NOTICE

(To owners of abutting property, municipal officials and newspapers)

Please take notice that The New England Division, Corps of Engineers
(Name of Applicant)

424 Trapelo Road, Waltham, Massachusetts 02254
(Address of Applicant)

is filing an application for a ~~[illegible]~~ Water Quality Certification with the Maine Department of Environmental Protection ~~[illegible]~~ to:

Directly place clean coarse sandfill along approximately 550 feet of the existing beach
(State specifically what is to be done)
from the existing backshore embankment, seaward, a distance of 50 feet(berm-width) at a height of 15 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 245 feet; also construct two terminal groin structures of approximately 195 foot length to be located at the northern and southern limits of the sandfill. The plan also includes 20 feet of rock revetment along the backshore embankment both north of the northern groin structure and south of the southern groin structure.

in, on or under a coastal wetland located in the town of Belfast.
(Name of Municipality)

The application will be filed for public inspection at the Department's Office in Augusta and at the municipal offices on March 12, 1985.

Written comments from any interested person must be sent to the Department of Environmental Protection within 14 days of filing of the application to receive consideration.

Request for a public hearing must also be sent to the Department of Environmental Protection within 14 days of filing of the application.

US Army Corps of Engineers
New England Division

News Release

Release No. 85-152	Contact: Sue Douglas
For Release: Upon Receipt	Phone: 617-647-8264

424 Trapelo Road, Waltham, MA. 02254-9149

ENVIRONMENT
RIVER SYSTEMS
RECREATION
FLOOD CONTROL
NAVIGATION
SHORE PROTECTION

March 12, 1985

ENGINEERS SEEK STATE WATER QUALITY CERTIFICATE FOR CITY PARK BEACH

WALTHAM, Mass. — The U.S. Army Corps of Engineers, New England Divisio has applied for a Water Quality Certificate from the Maine Department of Environmental Protection for a proposed beach erosion control project at City Park Beach, Belfast, Maine. The certificate is required by the Clean Water Act of 1977.

As proposed by the Engineers, the beach would be restored by the direct placement of about 18,000 cubic yards of sandfill to provide a 50-foot wide level beach berm along 550 feet of the beach. Two terminal groin structures would be constructed at the northern and southern limits of the beach to compartmentalize the sandfill. Also included in the proposal is th construction of backshore rock revetment extending approximately 20 feet from the outside of each groin structure. The project has an estimated cost of $363,000, with 70% being paid by the federal government.

Comments on the Engineers' application to the state and requests for a public hearing should be forwarded to the Department of Environmental Protection, State House, Augusta, ME 04333, not later than march 29, 1985.

-30-

PUBLIC NOTICE ATTACHED

NOTE: Use this form or one containing identical information

NOTICE

(To owners of abutting property, municipal officials and newspapers)

Please take notice that The New England Division, Corps of Engineers
(Name of Applicant)

424 Trapelo Road, Waltham, Massachusetts 02254
(Address of Applicant)

is filing an application for ~~[illegible]~~ Water Quality Certification with the Maine Department of Environmental Protection ~~[illegible]~~ to:

Directly place clean coarse sandfill along approximately 550 feet of the existing beach from the existing backshore embankment, seaward, a distance of 50 feet(berm-width) at a height of 15 feet above mlw, then sloping at a rate of 15 horizontal feet to 1 vertical foot until it meets the existing beach approximately 2 feet above mlw, for a total sandfill width of approximately 245 feet; also construct two terminal groin structures of approximately 195 foot length to be located at the northern and southern limits of the sandfill. The plan also includes 20 feet of rock revetment along the back shore embankment both north of the northern groin structure and south of the southern groin structure.
(State specifically what is to be done)

in, on or under a coastal wetland located in the town of Belfast
(Name of Municipality)

The application will be filed for public inspection at the Department's Office in Augusta and at the municipal offices on March 12, , 19 85 .

Written comments from any interested person must be sent to the Department of Environmental Protection within 14 days of filing of the application to receive consideration.

Request for a public hearing must also be sent to the Department of Environmental Protection within 14 days of filing of the application.

BRUHA/554/jaa

March 12, 1985

Planning Division
Coastal Development Branch

Mr. & Mrs. Roger Lothrop
Fahey Street
Belfast, Maine 04915

Dear Mr. & Mrs. Lothrop:

Enclosed is a copy of a Public Notice informing you of the application for Water Quality Certification, that has been filed with the Maine Department of Environmental Protection Agency for improving City Park Beach, Belfast, Maine.

This notice officially notifies you, the abutter, of the project.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

cc: CDB(3)
Read File
Plng Div File

BRUHA/554/jaa

March 12, 1985

Planning Division
Coastal Development Branch

Ms. Mary Perry
Fahey Street
Belfast, Maine 04915

Dear Ms. Perry:

Enclosed is a copy of a Public Notice informing you of the application for Water Quality Certification, that has been filed with the Maine Department of Environmental Protection Agency for improving City Park Beach, Belfast, Maine.

This notice officially notifies you, the abutter, of the project.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

cc: CDB(3)
Read File
Plng Div File

BRUHA/554/jaa

March 12, 1985

Planning Division
Coastal Development Branch

Ms. Ruth Briggs
P.O. Box 233
Belfast, Maine 04915

Dear Ms. Briggs:

Enclosed is a copy of a Public Notice informing you of the application for Water Quality Certification, that has been filed with the Maine Department of Environmental Protection Agency for improving City Park Beach, Belfast, Maine.

This notice officially notifies you, the abutter, of the project.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

cc: CDB(3)
Read File
Plng Div File

ERUHA/554/jaa

March 12, 1985

Planning Division
Coastal Development Branch

Ms. Priscilla Hardy
2 Mabelene Road
Charleston, S. Carolina 29418

Dear Ms. Hardy:

Enclosed is a copy of a Public Notice informing you of the application for Water Quality Certification, that has been filed with the Maine Department of Environmental Protection Agency for improving City Park Beach, Belfast, Maine.

This notice officially notifies you, the abutter, of the project.

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

cc: CDB(3)
Read File
Plng Div File

March 12, 1985

Planning Division
Coastal Development Branch

Mr. David Maynard
City Manager
City of Belfast
Belfast, Maine 04915

Dear Mr. Maynard:

This is to inform you that this office has applied to the State of Maine, Department of Environmental Protection, for Water Quality Certification (P.L. 92-500) at City Park Beach, Belfast, Maine.

A copy of the Public Notice was sent to the Republican Journal Newspaper, in Belfast, requesting that the notice be published, notifying area residents of the proposed improvement at the beach.

I am enclosing, for you, a copy of the Water Quality Certification application, which was forwarded to the Maine Department of Environmental Protection. Additional information enclosed, are copies of the Public Notice for the Chairman of the City Planning Board and other interested city officials or organizations you may feel should have a copy.

We have sent copies of the public notice to the abutting property owners; attached is a list of their names

Sincerely,

Joseph L. Ignazio
Chief, Planning Division

Enclosure

LIST OF ABUTTING PROPERTY OWNERS:

Priscilla Hardy
2 Mabelene Road
Charleston, South Carolina 29418

Ruth Briggs
P.O. Box 233
Belfast, Maine 04915

Mary Perry
Fahey Street
Belfast, Maine 04915

Mr. & Mrs. Roger Lothrop
Fahey Street
Belfast, Maine 04915

State of Maine, CZM Consistency Concurrence and Water Quality Certification to follow at a later date.

APPENDIX 7

GLOSSARY OF TERMS

APPENDIX 7

GLOSSARY OF TERMS

ACCRETION - A buildup of land which may be either natural or artificial. Natural accretion is the buildup of land, solely by the forces of nature, on a BEACH by deposition of waterborne or airborne material. Artificial accretion is a similar buildup of land by an act of man, such as the accretion formed by a groin, breakwater, or beach fill deposited by mechanical means.

ADVANCE (OF A BEACH) - (1) A continuing seaward movement of the shoreline. (2) A net seaward movement of the shoreline over a specified time.

ALONGSHORE - Parallel to and near the shoreline; same as LONGSHORE.

AMPLITUDE, WAVE - The magnitude of the displacement of a wave from a mean value. An ocean wave has an amplitude equal to the vertical distance from stillwater level to wave crest. For a sinusoidal wave, amplitude is one-half the wave height.

AQUIFER - Stratum or zone below the surface of the earth capable of producing water.

ARTIFICIAL NOURISHMENT - The process of replenishing a beach with material (usually sand) obtained from another location.

AWASH - Situated so that the top is intermittently washed by waves or tidal action. Condition of being exposed or just bare at any stage of the tide between high water and chart datum.

BACKSHORE - The zone of a shore or beach lying between the foreshore and the coastline and acted upon by waves only during severe storms, especially when combined with exceptionally high water. It comprises the BERM or BERMS. (See Figure 6-1 located at the end of glossary.)

BACKWASH - (1) The seaward return of the water following the uprush of the waves. (2) Water or waves thrown back by an obstruction such as a ship, breakwater or cliff.

BANK - (1) The rising ground bordering a lake, river or sea; the face of a scarp. (2) An elevation of the sea floor of large area, located on a continental (or island) shelf and over which the depth is relatively shallow but sufficient for safe surface navigation; a group of shoals. (3) In its secondary sense, a shallow area consisting of shifting forms of silt, sand, mud and gravel, but in this case it is only used with a qualifying word such as "sandbank" or "gravelbank".

BAR - A submerged or emerged embankment of sand, gravel or other unconsolidated material built on the sea floor in shallow water by waves and currents, especially at the mouth of a river or estuary or lying a short distance from, and usually parallel to, the beach. See BAYMOUTH BAR.

BARRIER BEACH - A bar essentially parallel to the shore, the crest of which is above normal high water level.

BASEMENT - Rock complex, generally of IGNEOUS and METAMORPHIC rocks, overlain UNCONFORMABLY by SEDIMENTARY strata.

BATHYMETRY - The measurement of depths of water in oceans, seas and lakes; also information derived from such measurements.

BAY - A recess in the shore or an inlet of a sea between two capes or headlands, not as large as a gulf but larger than a cove.

BAYMOUTH BAR - A bar extending partly or entirely across the mouth of a bay.

BEACH - A zone of unconsolidated material that extends landward from the low-water line to the place where there is marked change in material or physiographic form, or to the line of permanent vegetation (usually the effective limit of storm waves). The seaward limit of a beach - unless otherwise specified - is the mean low-water line. A beach includes FORESHORE and BACKSHORE. (See Figure 6-1.)

BEACH BERM - A flat terrace located at the top of the foreshore. Also, a nearly horizontal part of the beach or backshore formed by the deposit of material by wave action. Some beaches have no berms, others have one or several. (See figure 6-1.)

BEACH WIDTH - The horizontal dimension of the beach measured perpendicular to the shoreline.

BED - The smallest division of a stratified series, marked by a more or less well-defined divisional plane from its neighbors above and below.

BED FORMS - Any deviation from a flat bed that is readily detectable by eye, and higher than the largest sediment size present in the parent bed material; generated on the bed of an alluvial channel by the flow.

BEDROCK - Any solid rock exposed at the surface of the earth or overlaid with unconsolidated material.

BERM CREST - The seaward limit of a berm. (See Figure 6-1.)

BLOWOUT - A general term for various saucer-, cup- or trough-shaped hollows formed by wind erosion on a preexisting dune or other sand deposit.

BLUFF - Any high headland or bank presenting a precipitous front.

BOTTOM - The ground or bed under any body of water; the bottom of the sea. (See Figure 6-1.)

BOULDER - A rounded rock more than 10 inches in diameter.

BREAKER - A wave breaking on a shore.

BREAKWATER - A structure protecting a shore area, harbor, anchorage or basin from waves.

CHANNEL - (1) The part of a body of water deep enough to be used for navigation through an area otherwise too shallow for navigation. (2) The deepest part of a stream, bay or strait though which the main volume or current of water flows.

CHART DATUM - The plane or level to which soundings (or elevations) or tide heights are referenced. The surface is called a tidal datum when referred to a certain phase of tide. See also DATUM PLANE.

CLASTIC - Consisting of fragments of rocks or of organic structures that have been moved individually from their place of origin.

CLAY - Fine-grained soil consisting of organic material the grains of which have diameters smaller than 0.005 millimeters. Finer than SILT.

CLIFF - A high, steep face of rock; a precipice. See also MARINE CLIFF and SEA CLIFF.

COAST - A strip of land of indefinite width (may be several miles) that extends from the shoreline inland to the first major change in terrain features. (See Figure 6-1.)

COASTAL AREA - The land and sea area bordering the shoreline. (See Figure 6-1.)

COASTAL PLAIN - A plain composed of horizontal or gently sloping strata of CLASTIC materials fronting the coast.

COASTLINE - (1) Technically, the line that forms the boundary between the COAST and the SHORE. (2) Commonly, the line that forms the boundary between the land and the water.

COBBLE - A rock fragment between 65 and 256 millimeters in diameter, thus larger than a PEBBLE and smaller than a BOULDER, rounded or otherwise abraded in the course of aquenous, eolian or glacial transport.

CONTINENTAL SHELF - The zone bordering a continent and extending from the low-water line to the depth (usually about 100 fathoms) where there is a marked or rather steep descent toward a greater depth.

CONTOUR - A line on a map or chart representing points of equal elevation with relation to a datum.

CONVERGENCE - (1) In refraction phenomena, the decreasing of the distance between ORTHOGONALS in the direction of wave travel. Denotes an area of increasing wave height and energy concentration. Also FOCUSING. (2) In wind-setup phenomena, the increase in setup observed over that which would occur in an equivalent rectangular basin of uniform depth, caused by changes in planform or depth; also the decrease in basin width or depth causing such increase in setup.

COVE - A small, sheltered recess in a coast, often inside a larger embayment.

CREEP - Movement of an individual sand grain as a result of being hit by a windborne sand grain.

CREST OF WAVE - (1) The highest part of a wave. (2) That part of the wave above stillwater level. (See Figure 6-2. located at the end of the glossary.)

CROSSBEDDING - The arrangement of laminations of strata transverse or oblique to the main planes of stratification of the strata concerned; inclined, often lens-shaped beds between the main bedding planes.

CRYSTALLINE - An inexact general term for igneous or metamorphic rocks as opposed to sedimentary rocks.

CULM - STEM of grasses, usually hollow except at the swollen NODES.

CULTURAL EROSION - Erosion caused by effects of man's actions on the land-excavation, traffic (vehicular and foot) and construction (inland and shoreline).

CURRENT - A flow of water due to surface gradient, tidal phenomena, winds and/or differential atmospheric pressures. See EBB CURRENT, FLOOD CURRENT, LITTORAL CURRENT, LONGSHORE CURRENT, AND FIDAL CURRENT.

CURRENT RIPPLE - A ripple mark produced by the action of a current flowing steadily in one direction over a bed of sand. See also RIPPLES (BED FORMS).

CYCLONE - In the northern hemisphere, a storm characterized by strong winds rotating counterclockwise about a center of low atmospheric pressure.

DATUM PLANE - The horizontal plane to which soundings, ground elevations or water surface elevations are referred. Also REFERENCE PLANE. The plane is called a TIDAL DATUM when defined by a certain phase of the tide. On the Atlantic coast of the United States MEAN LOW WATER is the datum ordinarily used on hydrographic charts. A common datum used on topographic maps is based on MEAN SEA LEVEL.

DEEP WATER - Water so deep that surface waves are little affected by the ocean bottom. Generally, water deeper than one-half the surface wavelength is considered deep water.

DEFLATION - The removal of loose material from a beach or other land surface by wind action.

DEFOCUSING - The spreading farther apart of wave rays in shallow water than in deep water; height or amplitude of the breaking wave is less than at points where no defocusing occurs. See also DIVERGENCE.

DEGLACIATION - The uncovering of an area from beneath glacier ice as a result of shrinkage of a glacier.

DELTA - An alluvial deposit, roughly triangular or digitate in shape, formed at a river mouth.

DENUDATION - The stripping of forests and vegetation from the land.

DEPTH - The vertical distance from a specified tidal datum to the sea floor.

DISCOID - Having the form of a disk.

DIVERGENCE - (1) In refraction phenomena, the increasing of distance between ORTHOGONALS in the direction of wave travel. Denotes an area of decreasing wave height and energy concentration. Also DEFOCUSING. (2) In WIND-SETUP phenomena, the decrease in setup observed under that which would occur in an equivalent rectangular basin of uniform depth, caused by changes in planform or depth. Also the increase in basin width or depth causing such decrease in setup.

DOWNDRIFT - The direction of predominant movement of littoral materials.

DRIFT (noun) - (1) Sometimes used as a short form for LITTORAL DRIFT. (2) The speed at which a current runs. (3) Also floating material deposited on a beach (driftwood). (4) A deposit of a continental ice sheet, as a drumlin. See GLACIAL DRIFT

DRIFT DEPOSIT - Any accumulation of glacial origin; glacial or glaciofluvial deposit.

DUNE - Ridge or mound of loose, windblown material, usually sand.

EBB CURRENT - The tidal current away from shore or down a tidal stream; usually associated with the decrease in the height of the tide.

EBB TIDE - The period of tide between high water and the succeeding low water; a falling tide.

EMBAYMENT - An indentation in the shoreline forming an open bay.

EOLIAN SANDS - Sediments of sand size or smaller which have been transported by winds. They may be recognized in marine deposits off desert coast by the greater angularity of the grains compared with waterborne particles.

EQUATORIAL TIDES - Consecutive tides with similar ranges occurring when the moon's orbit is on or close to the equator; morning and afternoon tides are very much alike.

EROSION - The wearing away of land by the action of natural forces. On a beach, the carrying away of beach material by wave action, tidal currents, littoral currents, or by deflation.

EYE - In meteorology, usually the "eye of the storm" (hurricane); the roughly circular area of comparatively light winds and fair weather found at the center of a severe tropical cyclone.

EUSTATIC - Pertaining to simultaneous, world-wide changes in sea level; also related to the amount of water incorporated in ice caps.

EUTROPHICATION - Process occurring in a lake making it rich in dissolved nutrients, but dificient in oxygen.

FAN - An accumulation of debris brought down by a stream descending a steep ravine and debouching in the plain beneath, where the detrital material spreads out in the shape of a fan.

FATHOM - A unit of measurement used for soundings. It is equal to 6 feet (1.83 meters).

FETCH - The continuous area of open water over which the wind blows in a constant direction. In enclosed bodies of water, it would ususally coincide with the longest axis in the general wind direction. Sometimes used synonymously with FETCH LENGTH.

FETCH LENGTH - The horizontal distance (in the direction of the wind) over which the wind blows to generate SEAS or create a WIND SETUP.

FLOOD CURRENT - The tidal current toward shore, usually associated with the increase in the height of the tide.

FLOOD PLAIN - That portion of a river valley, adjacent to the river channel, that is built of sediments during the present regiment of the stream and that is covered with water when the river overflows its banks at flood stages.

FLOOD TIDE - The period of tide between low water and the succeeding high water; a rising tide.

FLUVIAL - Of or pertaining to rivers; produced by river action, as a fluvial plain.

FOCUSING - The closing together of wave rays in shallow water; height of breaking wave is greater than at points where there is no focusing. See also CONVERGENCE

FOREDUNE - The front dune immediately behind the backshore.

FORESHORE - The part of the shore lying between the crest of the seaward berm (or upper limit of wave wash at high tide) and the orinary low-water mark that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall. (See Figure 6-1.)

FOSSIL - The remains or traces of animals or plants that have been preserved by natural causes in the earth's crust exclusive of organisms that have been buried since the beginning of historic time.

FOSSILIFEROUS - Containing organic remains.

FRONTAL MARGIN - The leading edge of a glacier.

FULCRUM POINT - Point at which there is no net erosion or accretion; erosion occurs on one side of the fulcrum point, accretion on the other.

GALE - Continuous winds with velocities in excess of 32 miles per hour.

GENERATION OF WAVES - (1) The creation of waves by natural or mechanical means. (2) The creation and growth of waves caused by a wind blowing over a water surface for a certain period of time.

GLACIAL - Pertaining to, characteristic of, produced or deposited by or derived from a glacier.

GLACIAL DRIFT - Sediment (a) in transport in glaciers, (b) deposited by glaciers, and (c) predominantly of glacial origin, made in the sea or in bodies of glacial meltwater. See DRIFT.

GLACIATION - Alteration of the earth's solid surface through erosion and deposition by glacier ice.

GLACIER - A mass of ice with definite lateral limits, with motion in a definite direction and originating from the compacting of snow by pressure.

GLACIO- -A combining form frequently used with other words to denote formation by or relationship to glaciers.

GLACIOFLUVIAL - Pertaining to streams flowing from glaciers or to the deposits made by such streams.

GLACIOLACUSTRINE - Produced by or belonging to glacial lakes.

GRADIENT (GRADE) - With reference to winds or currents, the rate of increase or decrease in speed, usually in the vertical; or the curve that represents this rate. The change in a variable quantity, as temperature, per unit distance.

GRANITE - Loosely used for any light-colored, coarse-grained igneous rock. Actually an igneous rock consisting of essentially alkalic feldspar and quartz.

GRANITIC - Pertaining to or composed of granite or granite-like rock.

GRAVEL - Accumulation of rounded, waterworn PEBBLES. The word gravel is generally applied when the size of the pebbles does not much exceed that of an ordinary hen's egg; fragment size ranges from 76 to 4.76 millimeters; may or may not contain interstitial sand ranging from 50 to 70 percent of the total mass.

GROIN - A shore protection structure built (usually perpendicular to the shoreline) to trap littoral drift or retard erosion of the shore. Groins are usually constructed of rock, timber, or sheet piles. See LOW PROFILE GROIN and TERMINAL GROIN.

GROIN SYSTEM - A series of groins acting together to protect a section of beach. Commonly called a groin field.

GROUNDWATER - Subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the WATER TABLE.

GULF - A large embayment in a coast; the entrance is generally wider than the length.

HANGING VALLEY - A tributary valley whose floor is higher than the floor in the area of intersection.

HARBOR - Any protected water area affording a place of safety for vessels.

HEADLAND (HEAD) - A high, steep-faced promontory extending into the sea.

HIGH TIDE, HIGH WATER (HW) - The maximum elevation reached by each rising tide. See TIDE.

HIGH-WATER MARK - In the strict sense, the intersection of the plane of mean high water with the shore. The shoreline delineated on the nautical charts of the U.S Coast and Geodetic Survey is an approximation of the high-water line. For specific occurrences, the highest elevation on the shore reached during a storm or riding tide, including meteorological effects.

HOLLOW - A small ravine; a low tract of land encompassed by hills.

HOOK - A spit or norrow cape of sand or gravel which turns landward at the outer end.

HURRICANE - An intense tropical cyclone in which winds tend to spiral inward toward a core of low pressure, with maximum surface wind velocities that equal or exceed 75 miles per hour (65 knots) for several minutes or longer at some points. TROPICAL STORM is the term applied if maximum winds are less than 75 miles per hour.

HURRICANE PATH OR TRACK - Line of movement (propagation) of the eye through an area.

HYDROLOGY - The science that relates to the water of the earth.

IGNEOUS - Formed by solidification from a molten or partially molten state.

INLET - (1) A short, narrow waterway connecting a bay, lagoon or similar body of water with a large parent body of water. (2) An arm of the sea (or other body of water) that is long compared to its width and that may extend a considerable distance inland.

IN-MIGRATION - The net increase in population due to an excess of people moving in over people moving out.

INSHORE (ZONE) - The zone of variable width extending from the low-water line through the breaker zone. (See Figure 5-1.)

JETTY - On open seacoasts, a structure extending into a body of water and designed to prevent shoaling of a channel by littoral materials and to direct and confine the stream or tidal flow. Jetties are built at the mouth of a river or tidal inlet to help deepen and stabilize a channel.

KAME - A conical hill or short irregular ridge of gravel or sand deposited in contact with glacial ice.

KETTLE - A pit or depression in drift made by the wasting away of a detached mass of glacier ice that had been either wholly or partly buried in the drift.

KINETIC ENERGY (OF WAVES) - In a progressive oscillatory wave, a summation of the energy of motion of the particles within the wave.

KNOT - The unit of speed used in navigation. It is equal to 1 nautical mile (6,076,115 feet or 1,852 meters) per hour; about 1.15 statute miles per hour.

LAGOON - A shallow body of water, as a pond or lake, usually connected to the sea.

LANDFILL - A system of trash and garbage disposal in which the waste is buried between layers of earth.

LEACHATE - Highly concentrated effluent resulting from the leaching of landfills.

LEE - Shelter, or the part sheltered (or turned away) from the wind or waves.

LENGTH OF WAVE - The horizontal distance between similar points on two successive waves measured perpendicularly to the crest (See Figure 6-2.)

LIFT - A section of sand or snow fence designed to catch and hold windblown sand to increase the height of a dune.

LITHOLOGY - The physical character of a rock, generally determined megascopically or with the aid of a low-power magnifier.

LITTORAL - Of or pertaining to a shore, especially of the sea.

LITTORAL CURRENT - Any current in the littoral zone caused primarily by wave action, e.g., longshore current, rip current.

LITTORAL DEPOSITS - Deposits of littoral drift.

LITTORAL DRIFT - The sedimentary material moved in the littoral zone under the influence of waves and currents.

LITTORAL TRANSPORT - The movement of littoral drift in the littoral zone by waves and currents. Includes movement parallel (longshore transport) and perpendicular (onshore and offshore transport) to the shore.

LITTORAL TRANSPORT RATE - Rate of transport of sedimentary material parallel or perpendicular to the shore in the littoral zone. Usually expressed in cubic yards (meters) per year. Commonly used as synonymous with LONGSHORE TRANSPORT RATE.

LITTORAL ZONE - An indefinite zone extending seaward from the shoreline to just beyond the breaker zone.

LOBE - A projection of a glacial margin or of a body of glacial drift beyond the main mass of ice or drift.

LONGSHORE - Parallel to and near the shoreline.

LONGSHORE CURENT - The littoral current in the breaker zone moving essentially parallel to the shore, usually generated by waves breaking at an angle to the shoreline.

LONGSHORE ENERGY FLUX - It is equal to the component of wave energy flux per unit length of shoreline which is parallel to the shoreline. See WAVE ENERGY FLUX.

LONGSHORE TRANSPORT - The movement of sedimentary material parallel to the shore. The rate of longshore transport is usually expressed in cubic yards (meters) per year. Commonly used as synonymous with LITTORAL TRANSPORT.

LOW PASS FILTER - A device (electronic or digital) that attenuates the higher frequency components of a signal but that leaves the amplitude of the lower frequency components unaffected.

LOW PROFILE GROIN - A groin placed (usually midway along the proposed project) at or just below the proposed or existing ground. See GROIN.

LOW TIDE (LOW WATER, LW) - The minimum elevation reached by each falling tide. See TIDE.

LOW-WATER MARK - The intersection of any standard low tide datum plane with the shore.

MARINE CLIFF - A cliff, sometimes composed of unconsolidated sediments, facing the ocean and formed by wave action.

MARSH - An area of soft, wet or periodically inundated land, generally treeless and usually characterized by grasses and other low growth.

MASS TRANSPORT - The net transfer of water by wave action in the direction of wave travel. See ORBIT.

MEAN HIGH WATER (MHW) - The average height of the high waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value.

MEAN LOW WATER (MLW) - The average height of the low waters over a 19-year period. For shorter periods of observations, corrections are applied to eliminate known variations and reduce the results to the equivalent of a mean 19-year value.

MEAN SEA LEVEL - The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.

MELT WATER - Water resulting from the melting of snow or of glacial ice.

METAMORPHIC ROCK - Includes all those rocks that have formed in the solid state in response to pronounced changes of temperature, pressure and chemical environment, which generally take place below the zones of weathering and cementation.

MIGRATE - To translocate (as a dune, spit or inlet, more or less as a unit) under the continued action of wind, waves and currents.

MORAINE - Drift deposited chiefly by direct glacial action and having constructional topography independent of control by the surface on which the drift lies.

MORPHOLOGY - The observation of the form of lands.

MUD - A fluid-to-plastic mixture of finely divided particles of solid material and water.

MUD FLAT - An accumulation of mud that is exposed at low tide and covered by shallow water at high tide.

NAUTICAL MILE - Generally 1 minute of latitude is considered equal to 1 nautical mile. The accepted United States value as of 1 July 1959 is 6,076.115 feet or 1,852 meters, approximately 1.15 times as long as the statute mile of 5,280 feet. Also geographical mile.

NEAP TIDE - A tide occurring near the time of quadrature of the moon with the sun. The neap tidal rage is usually 10 to 30 percent less than the mean tidal range.

NEARSHORE (ZONE) - An indefinite zone extending seaward from the shoreline well beyond the breaker zone. (See Figure 5-1.)

NODAL POINT - The point where the predominant direction of the LONGSHORE TRANSPORT changes. The point at which the longshore current of sediment transport changes sign.

NODE - Joint of a STEM where a leaf is borne or may be borne. Buds are also commonly borne at the node.

NORTHEASTER - Any east coast storm (except a hurricane) of the middle Atlantic and New England States that produces strong onshore winds.

NOURISHMENT - The process of replenishing a beach. It may be brought about naturally by longshore transport or artificially by the deposition of dredged materials.

NUTRIENT - A nutritive substance or ingredient, referring here to organic nutrients in the soil and underlying sediments both above and in the water table.

OFFSHORE - (1) The comparatively flat zone of variable width, extending from the breaker zone to the seaward edge of the Continental Shelf. (2) A direction seaward from the shore. (See Figure 6-1.)

OFFSHORE WIND - A wind blowing from land to sea in the coastal area.

ONSHORE - A direction from sea to land.

ONSHORE WIND - A wind blowing from sea to land in the coastal area.

ORBIT - In water waves, the path of a water particle affected by the wave motion. In deep-water waves the orbit is nearly circular and in shallow-water waves the orbit is nearly elliptical. In general, the orbits are slightly open in the direction of wave motion giving rise to MASS TRANSPORT.

ORTHOGONALS - On a wave-refraction diagram, a line drawn perpendicular to the wave crests. Also WAVE RAY.

OUTFALL - A structure extending into a body of water for the purpose of discharging sewage, storm runoff or cooling water.

OUTWASH - Materials deposited by meltwater streams beyond active glacier ice.

OUTWASH PLAIN - Fan-shaped overlapping deltas deposited by streams flowing from the glacier.

OVERTOPPING - Passing of water over the top of a structure as a result of wave runup or surge action.

PAMET - An outwash channel carved in glacial drift and having irregularities resulting from melting of blocks of stagnant ice.

PAMET SAG - Depression in the edge of the scarp caused by its intersection by a pamet.

PARABOLIC DUNE - A dune having (in ground plan) approximately the form of a parabola, with the concave side toward the wind.

PEAT - A dark-brown or black residuum produced by the partial decomposition of various plants (mosses, trees, etc.) that grow in marshes and similar wet places.

PEBBLES - Smooth rounded stones ranging in diameter from 2 to 64 millimeters.

PHASE SHIFT - A shift to the right of a sine wave.

PHI GRADE SCALE - A logarithmic transformation of the Wentworth grade scale for size classification of sediment grains based on the negative logarithm to the base 2 of the particle diameter. Measured in Phi units.

PITTED OUTWASH PLAIN - An outwash plain of gravel or sand with kettle holes.

PLEISTOCENE - The earlier of the two epochs comprising the Quaternary period. Also called Glacial epoch and formerly called Ice Age.

POINT - The extreme end of a cape or the outer end of any land area protruding into the water, usually less prominent than a cape.

PROFILE, BEACH - The intersection of the ground surface with a vertical plane; may extend from the top of the dune line to the seaward limit of sand movement. (See Figure 6-1.)

PROGLACIAL LAKE - Lake occupying a basin in front of a glacier generally in direct contact with the ice.

PROGRADATION - A seaward advance of the beach berm.

PROPAGATION OF WAVES - The transmission of waves through water.

QUARTZITE - A granulose metamorphic rock consisting essentially of quartz.

RADIOCARBON DATING - The determination of the age of a material by measuring the propagation of the isotope C^{14} (radiocarbon) in the carbon it contains. The method is suitable for the determination of ages up to a maximum of about 30,000 years.

RECESSION (OF A BEACH) - (1) A continuing landward movement of the shoreline. (2) A net landward movement of the shoreline over a specified time. Also RETROGRESSION.

RECESSIONAL MORAINE - A moraine formed during a temporary decrease in the rate of glacial retreat.

RECHARGE - The processes by which water is absorbed and is added to the zone of saturation. Also, the quantity of water that is added to the zone of saturation.

RECURVED SPIT - A SPIT having one end more or less strongly curved inward (landward).

REFRACTION (OF WATER WAVES) - (1) The process by which the direction of a wave, moving in shallow water at an angle to the contours, is changed. The part of the wave advancing in shallower water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) The bending of wave crests by currents.

RETROGRADATION - The cutting back of a beach toward land.

RETROGRESSION (OF A BEACH) - (1) A continuing landward movement of the shoreline. (2) A net landward movement of the shoreline over a specified time. Also RECESSION, RETROGRADATION.

REVETMENT - A facing of stone, concrete, etc., built to protect a scarp, embankment or shore structures against erosion by wave action or currents.

RIP CURRENT - A strong surface current flowing seaward from the shore. It usually appears as a visible band of agitated water and is the return movement of water piled up on the shore by incoming waves and wind. With the seaward movement concentrated in a limited band, its velocity is somewhat accentuated.

RIPPLES (BED FORMS) - Small bed forms with wavelengths less than 1 foot and heights less than 0.1 foot.

RIPRAP - A layer, facing or protective mound of stones randomly placed to prevent erosion, scour or sloughing of a structure or embankment; also the stone so used.

RUBBLE - (1) loose angular waterworn stones along a beach. (2) Rough, irregular fragments of broken rock.

RUBBLE-MOUND STRUCTURE - A mound of randomly shaped and randomly placed stones protected with a cover layer of selected stones or specially shaped concrete armor units. (Armor units in primary cover layer may be placed in orderly manner or dumped at random.)

SALTATION - That method of sand movement of randomly shaped and randomly placed stones protected with a cover layer of selected stones or specially shaped concrete armor units. (Armor units in primary cover layer may be placed in orderly manner or dumped at random.)

SALTATION - That method of sand movement in a fluid in which individual particles leave the bed by bounding nearly vertically and, because the motion of the fluid is not strong or trubulent enough to retain them in suspension, return to the bed at some distance downstream. The travel path of the particles is a series of hops and bounds.

SALT MARSH - A mud flat that has reached sea level enabling salt-tolerant plants to grow, thus producing a tough, erosion-resistant vegetal mat that reaches approximately the level of high tide.

SAND - Detrital material ranging in size from 2 to 1/16 millimeters in diameter.

SANDFILL - Sand added to a beach as a shore-protection measure.

SCARP - A more or less continuous line of cliffs or steep slopes facing in one general direction that are caused by erosion or faulting. (See Figure 6-1.)

SCARP, BEACH - An almost vertical slope along the beach caused by erosion by wave action. It may vary in height from a few inches to several feet, depending on wave action and the nature and composition of the beach. (See Figure 6-1.)

SCOUR - Removal of underwater material by waves and currents, especially at the base or toe of a shore structure.

SEA CLIFF - A cliff situated at the seaward edge of the coast and formed by wave action.

SEAS - Waves caused by wind at the place and time of observation.

SEAWALL - A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action.

SEDIMENT - Solid material, both mineral and organic, that is in suspension, is being transported or has been moved from its site of origin by air, water or ice and has come to rest on the earth's surface either above or below sea level.

SEDIMENTARY ROCKS - Rocks formed by the accumulation of sediment in water (aqueous deposits) or from air (eolian deposits). The fragments or particles are of various sizes (conglomerate, sandstone, shale), of the remains or products of animals or plants (certain limestones and coal), of the product of chemical action or of evaporation (salt, gypsum, etc.) or of mixtures of these materials. A characteristic feature of sedimentary deposits is a layered structure known as bedding or stratificaiton. Each layer is a bed or stratum. Sedimentary beds as deposited lie flat or nearly flat.

SEPTAGE - The solid waste from on-site septic systems.

SHALLOW WATER - (1) Commonly, water of such a depth that surface waves are noticeably affected by bottom topography. It is customary to consider water of depths less than one-half the surface wavelengths as shallow water. See DEEP WATER. (2) More strictly, in hydrodynamics with regard to progressive gravity waves, water in which the depth is less than 1/25 the wave-length. Also called very shallow water.

SHINGLE - (1) Loosely and commonly, any beach material coarser than ordinary gravel, especially any having flat or flattish pebbles. (2) Strictly and accurately, beach material of smooth, well-rounded pebbles that are roughly the same size. The spaces between pebbles are not filled with finer materials. Shingle often gives out a musical sound when stepped on.

SHOAL (noun) - A detached elevation of the sea bottom, comprised of any material except rock or coral, which may endanger surface navigation.

SHOAL (verb) - (1) To become shallow gradually. (2) To cause to become shallow. (3) To proceed from a greater to a lesser depth of water.

SHORE - The narrow strip of land in immediate contact with the sea, including the zone between high and low water lines. A shore of unconsolidated material is usually called a beach. (See Figure 6-1.)

SHORELINE - The intersection of a specified plane of water with the shore or beach (e.g., the high-water shoreline would be the intersection of the plane of mean high water with the shore or beach.) The line delineating the shoreline on U.S. Coast and Geodetic Survey nautical charts and surveys approximates the mean high-water line.

SHORELINE-BREAKER ANGLE - The angle that a breaking wave makes with the shoreline.

SILICIFIED - Replaced by or having the interstitial spaces filled with fine-grained silica.

SILT - A very fine-grained sediment, most of the particles of which are between 1/16 and 1/256 millimeters in diameter.

SLIP FACE - The steep, leeward side of a migrating dune.

SLUMP - The downward slipping of a mass of rock or unconsolidated material of any size, moving as a unit or as subsidiary units, usually with backward rotation of a more or less horizontal axis parallel to the cliff or slope from which it descends.

SORTING - (1) In a genetic sense the term may be applied to the dynamic process by which material having some particular characteristic, such as similar size, shape or specific gravity, is selected from a larger heterogeneous mass. (2) In a descriptive sense the term may be used to indiate the degree of similarity, in respect to some particular characteristic, of the component parts in a mass of material.

SORTING COEFFICIENT - A mathematical measure of the degree of sorting of a sediment.

SPIT - A small point of land or a narrow shoal projecting into a body of water from the shore.

SPUR - A short section of sand fence attached to and perpendicular to a longer section that is parallel to the beach.

STEM - The ascending axis of a plant, whether above or below ground, which ordinarily grows in an opposite direction to the root or descending axis.

STILLWATER LEVEL - The elevation that the surface of the water would assume if all wave action were absent.

STRATIFIED - Formed or lying in beds, layers or strata.

STRATIFIED DRIFT - Drift exhibiting both sorting and stratification, implying deposition from a fluid medium such as water or air.

STRATIGRAPHIC - Of, relating to or determined by stratigraphy. The study and correlation of stratified rocks according to origin, composition, distribution and succession of strata.

SURFICIAL GEOLOGY - The study of materials formed on, situated at or occurring on the earth's surface (especially unconsolidated residual, alluvial or glacial deposits lying on the bedrock).

SURF ZONE - The area between the outermost breaker and the limit of wave uprush.

SWASH - The rush of water up onto the beach face following the breaking of a wave.

SWELL - Wind-generated waves that have traveled out of their generating area. A swell characteristically exhibits a more regular and longer period and has flatter crests than waves that are near their area of generation.

TERMINAL GROIN - A groin placed (usually at the beginning or end of a proposed project) about 1 foot above the surface. See GROIN.

TERMINAL MORAINE - A moraine formed across the course of a glacier at its farthest advance, at or near a relatively stationary edge or at places marking the termination of important glacial advances.

TIDAL CURRENT - The alternating horizontal movement of water associated with the rise and fall of the tide caused by the astronomical tide producing forces. See also FLOOD CURRENT AND EBB CURRENT.

TIDAL, RANGE - The difference in height between consecutive high and low (or higher high and lower low) waters.

TIDE - The periodic rising and falling of the water that results from gravitational attraction of the moon and sun and other astronomical bodies acting upon the rotating earth. Although the accompanying horizontal movement of the water resulting from the same cause is also sometimes called the tide, it is preferable to designate the latter as TIDAL CURRENT, reserving the name TIDE for the vertical movement.

TILL - Unsorted, unstratified sediment carried or deposited by a glacier.

TOPOGRAPHY - The configuration of a surface, including its relief, the position of its streams, roads, buildings, etc.

TROPICAL CYCLONE - See HURRICANE.

TROPICAL STORM - A tropical cyclone with maximum winds less than 75 miles per hour.

TURBULENT FLOW - That type of flow in which the stream lines are thoroughly confused through heterogeneous mixing of flow as opposed to laminar flow in which the stream lines remain distinct from one another over their entire body.

UNCONFORMABLY - Not succeeding the underlying strata in immediate order of age and in parallel position.

UNSTRATIFIED - Not formed or deposited in beds or strata.

WASHOVER - Small delta built on the landward side of a bar separating a lagoon from the open sea. A washover results from storm waves breaking over low parts of the bar and depositing sediment on the lagoon side.

WASHOVER CHANNEL - Depression leading across a low dune from the ocean side to the washover on the lagoon side. Formed when a wave breaches a low dune.

WATER TABLE - The upper surface of a zone of saturation, except where that surface is formed by an impenetrable body.

WAVE - A ridge, deformation or undulation of the surface of a liquid.

WAVE DIRECTION - The direction from which a wave approaches.

WAVE ENERGY FLUX - The rate at which energy is transmitted in the direction of wave propagation across a plane perpendicular to the direction of wave advance and extending down the entire depth.

WAVE FRONT - On a wave refraction diagram, a line drawn parallel to the wave crests or perpendicular to the wave rays. (See Figure 6-3.)

WAVE HEIGHT - The vertical distance between a crest and the preceding trough.

WAVELENGTH - The horizontal distance between similar points on two successive waves measured perpendicular to the crest. (See Figure 6-2.)

WAVE PERIOD - The time for a wave crest to traverse a distance equal to one wavelength. The time for two successive wave crests to pass a fixed point.

WAVE RAY - On a wave-refraction diagram, a line drawn perpendicular to the wave crests. Also ORTHOGONAL. (See Figure 6-3.)

WAVE RAY-SHORELINE ANGLE - The angle that an incoming wave ray makes with the shoreline.

WAVE SETUP - Superelevation of the water surface over normal surge elevation due to onshore mass transport of the water by wave action alone.

WAVE TROUGH - The lowest part of a wave form between successive crests. Also that part of a wave below stillwater level.

WEATHERED - Altered by a group of processes, such as the chemical action of air and rain water and of plants and bacteria and the mechanical action, change in character, decay and finally crumble into soil.

WIND SETUP - (1) The vertical rise in the stillwater level on the leeward side of a body of water caused by wind stresses on the surface of the water. (2) The difference in stillwater levels on the windward and the leeward sides of a body of water caused by wind stresses on the surface of the water. (3) Synonymous with STORM SURGE. STORM SURGE is usually reserved for use on the ocean and large bodies of water. WIND SETUP is usually reserved for use on reservoirs and smaller bodies of water.

WINDWARD - The direction from which the wind is blowing.

WISCONSIN - Fourth Pleistocene epich of glaciation.

SOURCES

Definitions in this glossary came from the following sources:

American Geological Institute, 1962. Dictionary of Geological Terms, Dolphin books, Doubleday & Company, Inc., Garden City, New York.

U.S. Army Coastal Engineering Research Center, 1975. Shore Protection Manual. Three Volumes. U.S. Army Coastal Engineering Research Center, Kingman Building, Fort Belvoir, Virginia.

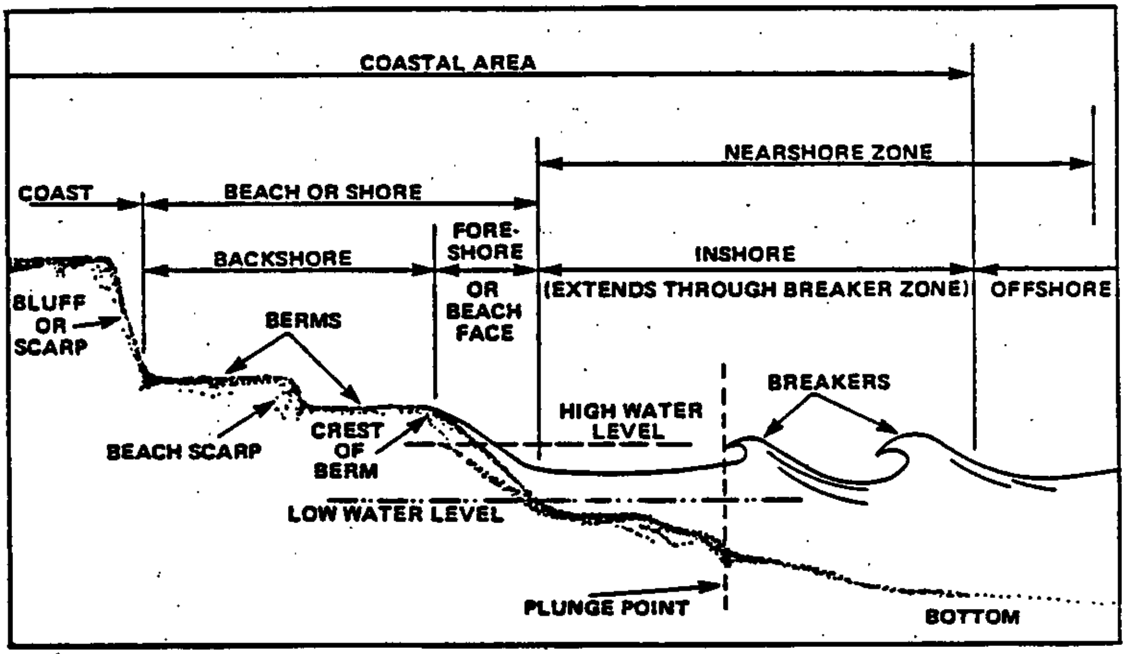


Figure 6-1. Beach Profile-Related Terms (after U.S. Army Coastal Engineering Research Center, 1975)

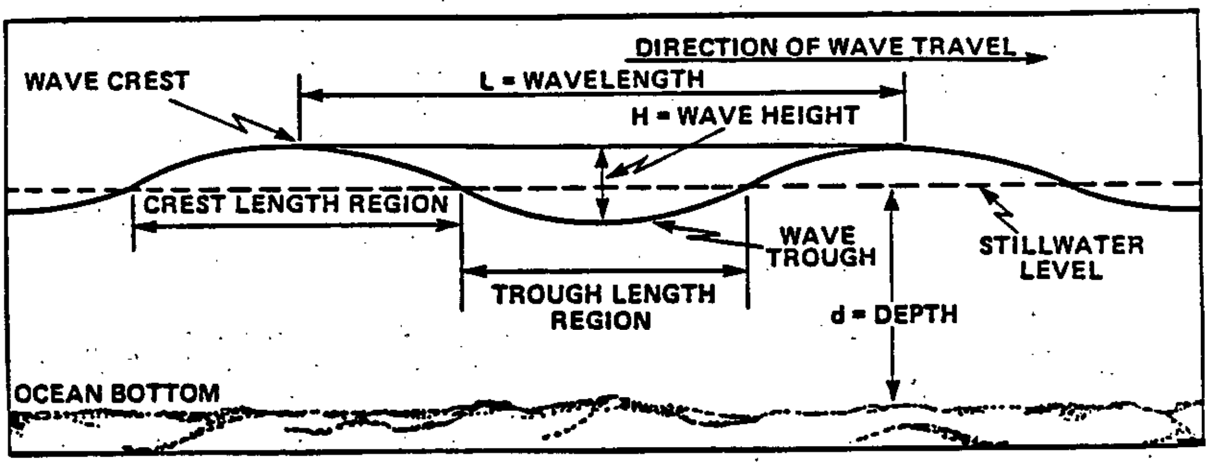


Figure 6-2. Wave Characteristics and Direction of Water Particle Movement (after Wiegel, 1953).

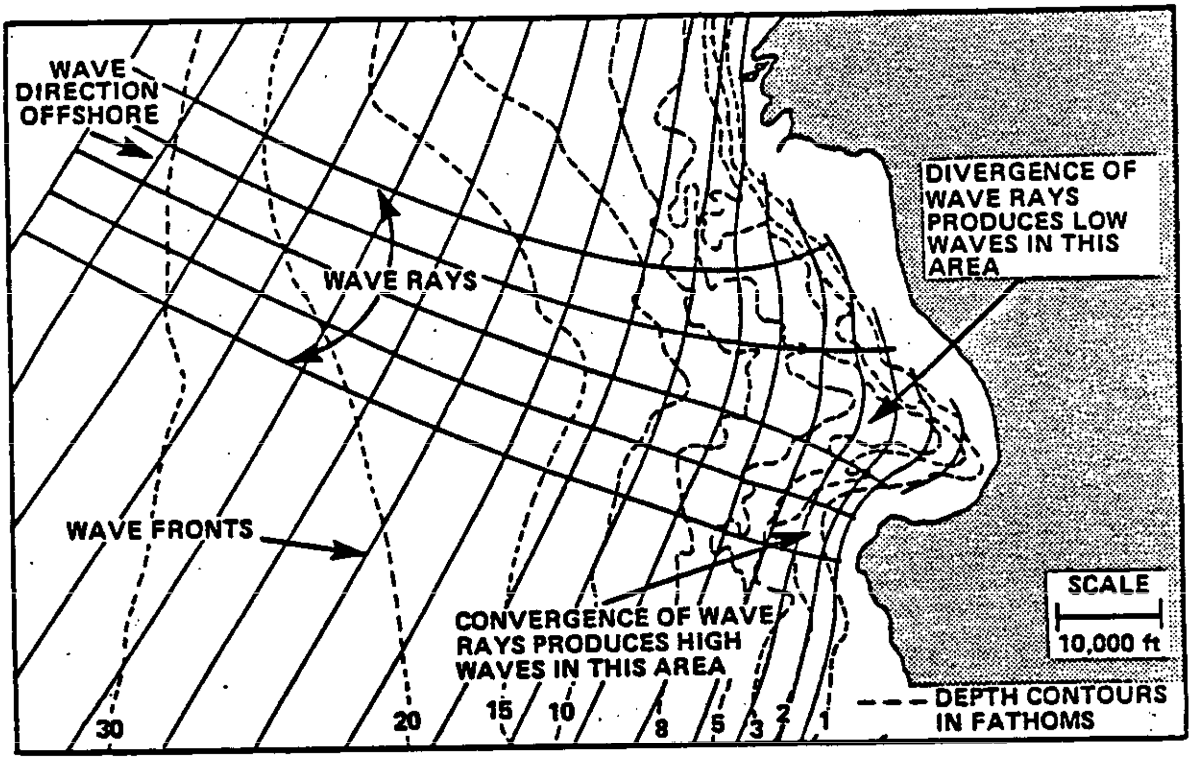


Figure 6-3. Refraction Diagram (after Wiegel, 1953)

PHOTO 1 - Looking north along Belfast City Park Beach at high tide.

PHOTO 2 - Looking south along Belfast City Park Beach at high tide.

PHOTO 3 - Looking north along Belfast City Park Beach at low tide.

PHOTO 4 - Looking south along Belfast City Park Beach at low tide.

PHOTO 5 - View of backshore park looking from the beach area.

PHOTO 6 - View of drainage runoff ditch from backshore to beach.

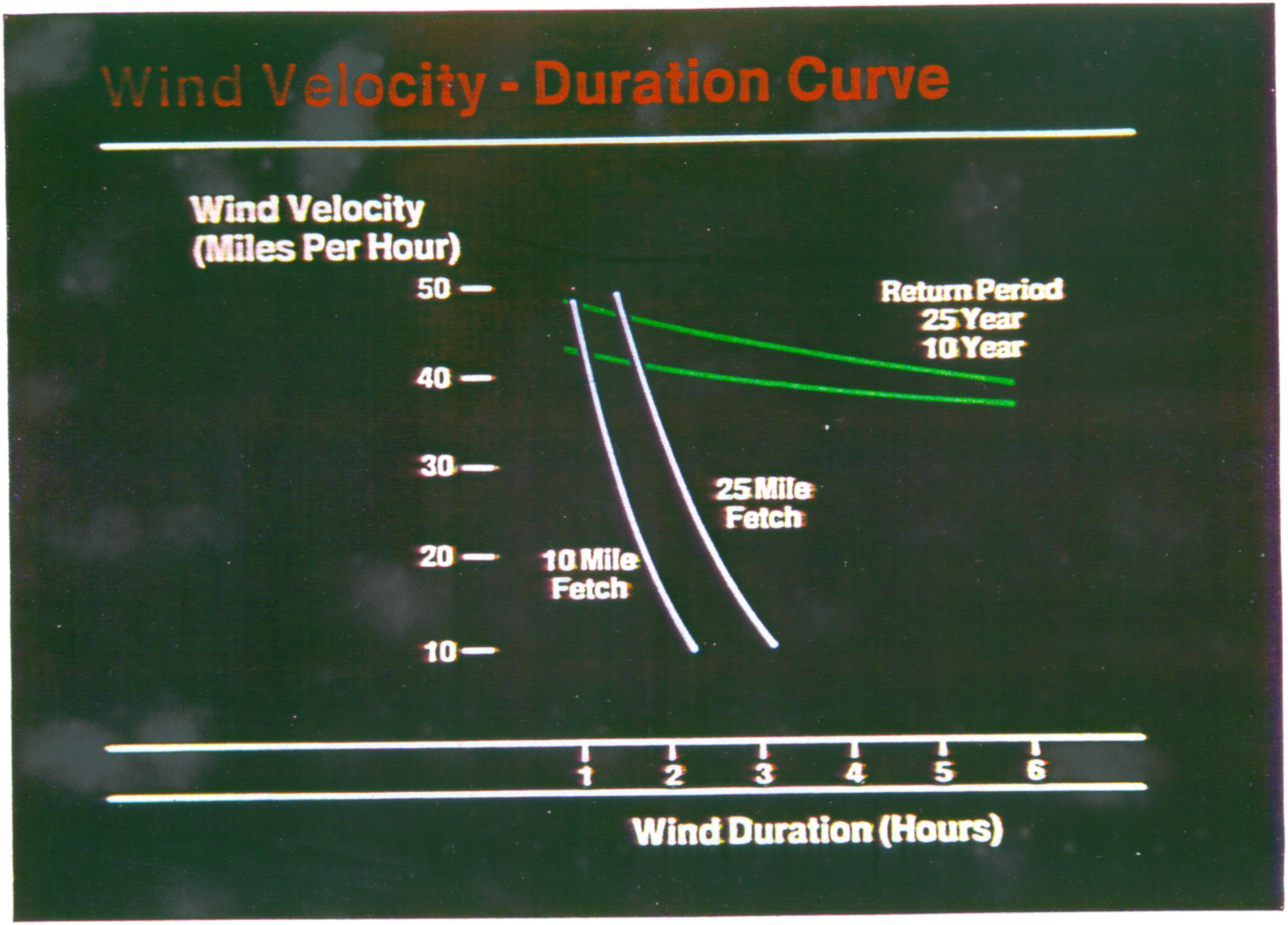
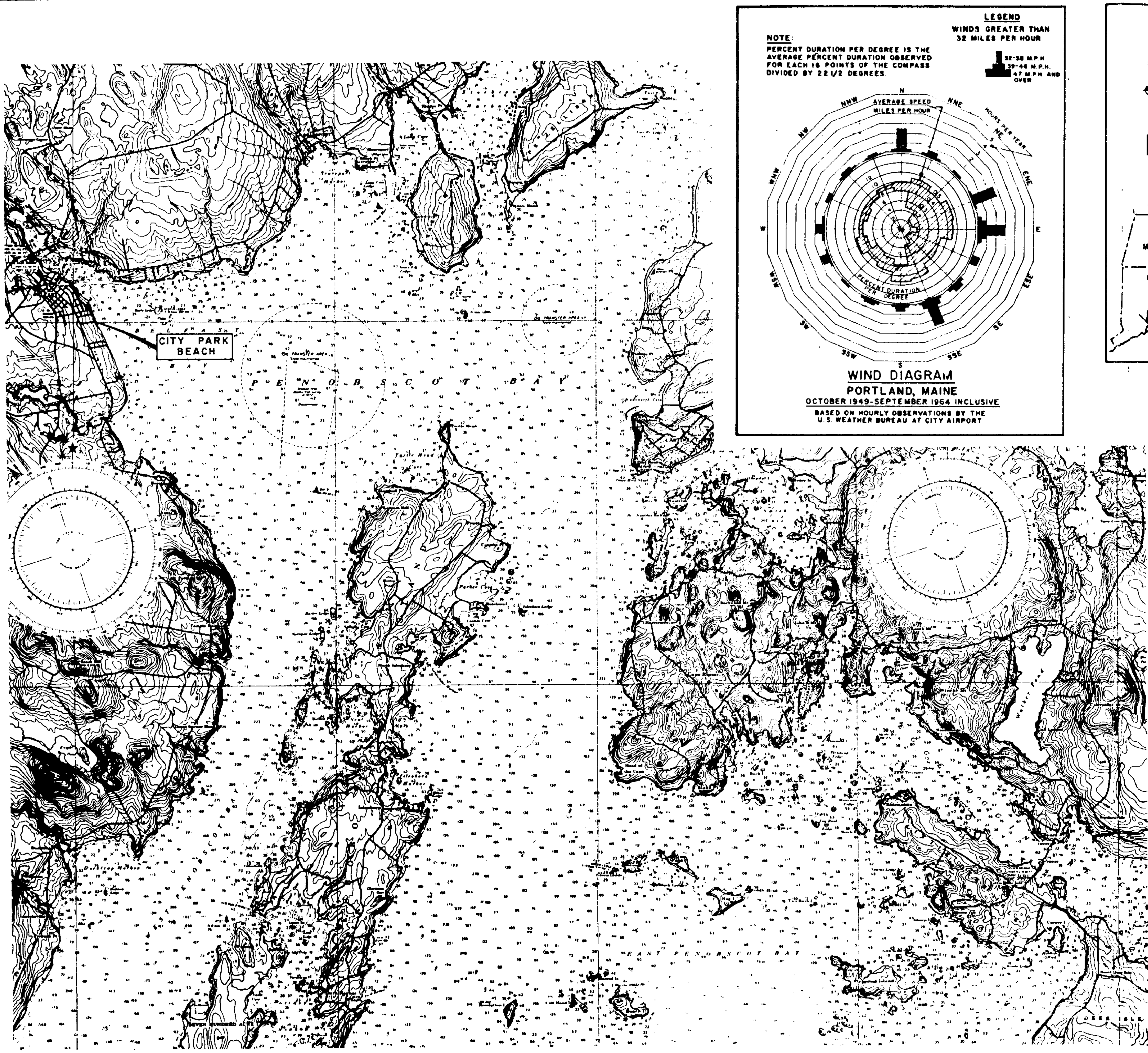
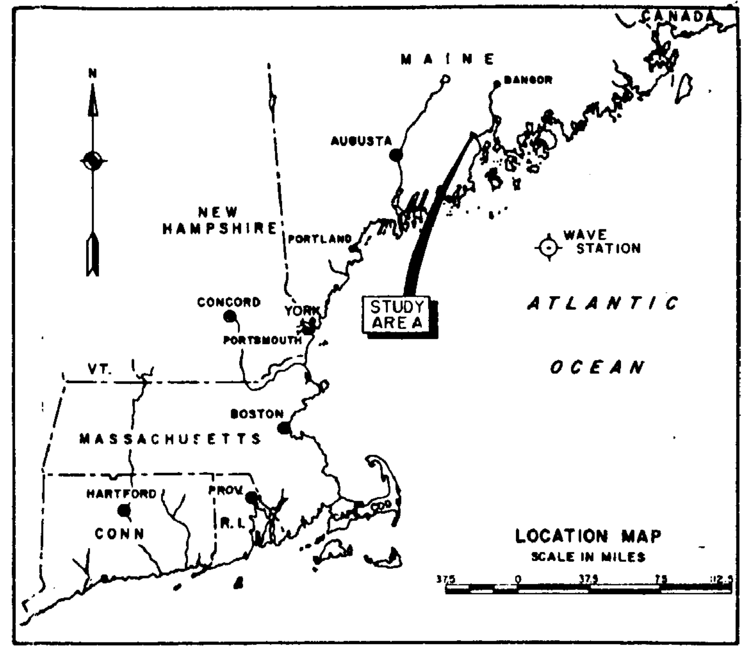
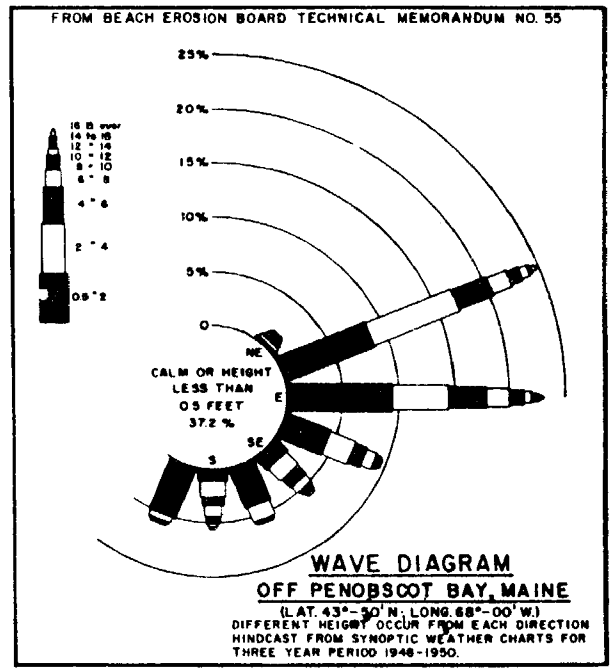

Wind Velocity - Duration Curve
Wind Velocity
(Miles Per Hour)
50
40
30
20
10
Return Period
25 Year
10 Year
25 Mile
Fetch
10 Mile
Fetch
1
2
3
4
5
6
Wind Duration (Hours)

FIGURE 2-4







BEACH EROSION CONTROL STUDY

BELFAST CITY PARK BEACH

BELFAST, MAINE

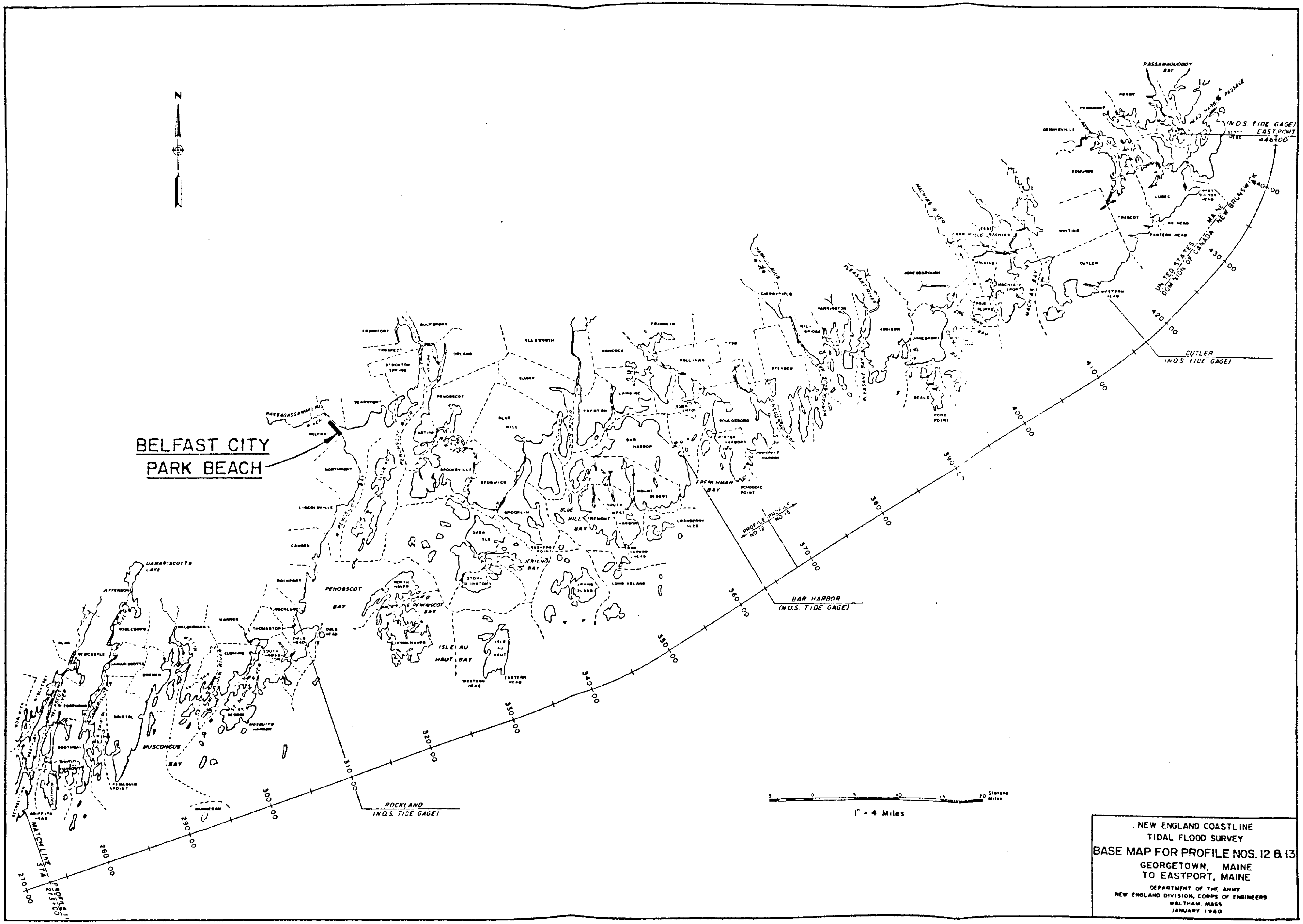
LOCATION MAP

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

COMPLIANCE WITH ENVIRONMENTAL PROTECTION STATUTES AND EXECUTIVE ORDERS

Statutes	Compliance
1. Archeological and Historic Preservation Act, as ammended, 16 U.S.C. 469 <u>et seq.</u>	No cultural resources would be impacted by the proposed action.
2. Clean Air Act, as amended, 42 U.S.C. 7401 <u>et seq.</u>	Submission of this report to the Regional Administrator of the Environmental Protection Agency (EPA) for review constitutes compliance with Act.
3. Clean Water Act (Federal Water Pollution Control Act), as amended, 33 U.S.C. 1251 <u>et seq.</u>	A Section 404(b)(1) Evaluation has been prepared as part of this document. A Water Quality Certificate under Section 401 of this Act will be applied for.
4. Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 <u>et seq.</u>	A CZM consistency determination concurrence will be sought from the State.
5. Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 <u>et seq.</u>	Coordination with the U.S. Fish and Wildlife Service and the NMFS of the proposed action has yielded no formal consultation requirments.
6. Estuary Protection Act, 16 U.S.C. 1221 <u>et seq.</u>	Coordination with the Department of Interior constitutes compliance with this Act.
7. Federal Water Project Recreation Act, as amended, 16 U.S.C. 4601-12 <u>et seq.</u>	Same as above.
8. Fish and Wildlife Coordination Act, as amended, 16 U.S.C. 661 <u>et seq.</u>	Coordination with the U.S. Fish and Wildlife Service and the NMFS constitutes compliance of this action
9. Land and Water Conservation Fund Act of 1965, as amended, 16 U.S.C. 4601-3 <u>et seq.</u>	Coordination with the Department of the Interior constitutes compliance with this Act.
10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1401 <u>et seq.</u>	Not Applicable.
11. National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470 <u>et seq.</u>	No cultural resources would be impacted by the proposed action.
12. National Environmental Policy Act of 1969, as amended, 42 U.S.C. 432 <u>et seq.</u>	The preparation of this document constitutes compliance with this Act.
13. Rivers and Harbors Act of 1899, as amended, 33 U.S.C. 401 <u>et seq.</u>	Not Applicable.
14. Watershed Protection and Flood Prevention Act, as amended, 16 U.S.C. 1001 <u>et seq.</u>	Not Applicable.
15. Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 <u>et seq.</u>	Not Applicable.

Executive Orders	Compliance
1. Executive Order 11988, Floodplain Management, 24 May 1977.	Not Applicable.
2. Executive Order 11990, Protection of Wetlands, 24 May 1977.	Not Applicable.
3. Executive Order 12114, Environmental Effects Aboard of Major Federal Actions, 4 January 1979.	Not Applicable.


BELFAST CITY
PARK BEACH
NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
BASE MAP FOR PROFILE NOS. 12 & 13
GEORGETOWN, MAINE
TO EASTPORT, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS
JANUARY 1980
1" = 4 Miles
(NOS TIDE GAGE)
EASTPORT
446+00
CUTLER
(NOS TIDE GAGE)
BAR HARBOR
(N.O.S. TIDE GAGE)
ROCKLAND
(NOS. TIDE GAGE)
PROFILE NO 12
PROFILE NO 13
FRENCHMAN BAY
PENOBSCOT BAY
ISLE AU HAUT BAY
BLUE HILL BAY
MUSCONGUS BAY
UNITED STATES
DOMINION OF CANADA
MAINE
NEW BRUNSWICK
MATCH LINE STA
270+00
280+00
290+00
300+00
310+00
320+00
330+00
340+00
350+00
360+00
370+00
380+00
390+00
400+00
410+00
420+00
430+00
440+00

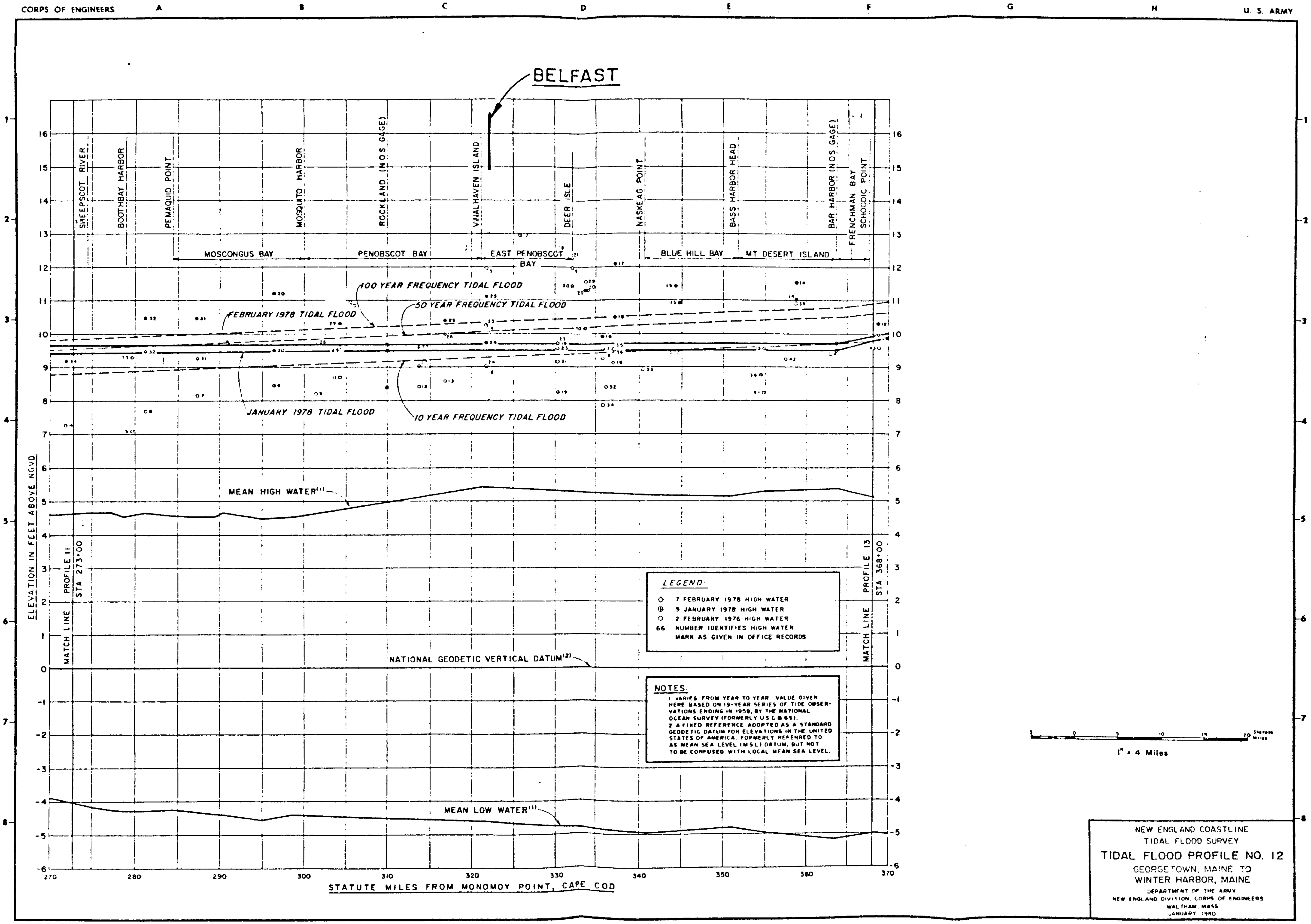

CORPS OF ENGINEERS
U. S. ARMY
BELFAST
SHEEPSCOT RIVER
BOOTHBAY HARBOR
PEMAQUID POINT
MOSQUITO HARBOR
ROCKLAND (NOS GAGE)
VINALHAVEN ISLAND
DEER ISLE
NASKEAG POINT
BASS HARBOR HEAD
BAR HARBOR (NOS GAGE)
FRENCHMAN BAY
SCHOODIC POINT
MOSCONGUS BAY
PENOBSCOT BAY
EAST PENOBSCOT BAY
BLUE HILL BAY
MT DESERT ISLAND
100 YEAR FREQUENCY TIDAL FLOOD
50 YEAR FREQUENCY TIDAL FLOOD
FEBRUARY 1978 TIDAL FLOOD
JANUARY 1978 TIDAL FLOOD
10 YEAR FREQUENCY TIDAL FLOOD
MEAN HIGH WATER(1)
NATIONAL GEODETIC VERTICAL DATUM(2)
MEAN LOW WATER(1)
ELEVATION IN FEET ABOVE NGVD
MATCH LINE PROFILE 11 STA 273+00
MATCH LINE PROFILE 13 STA 368+00
STATUTE MILES FROM MONOMOY POINT, CAPE COD
LEGEND:
7 FEBRUARY 1978 HIGH WATER
9 JANUARY 1978 HIGH WATER
2 FEBRUARY 1976 HIGH WATER
66 NUMBER IDENTIFIES HIGH WATER MARK AS GIVEN IN OFFICE RECORDS
NOTES:
1 VARIES FROM YEAR TO YEAR. VALUE GIVEN HERE BASED ON 19-YEAR SERIES OF TIDE OBSERVATIONS ENDING IN 1959, BY THE NATIONAL OCEAN SURVEY (FORMERLY U.S.C.&G.S.).
2 A FIXED REFERENCE ADOPTED AS A STANDARD GEODETIC DATUM FOR ELEVATIONS IN THE UNITED STATES OF AMERICA. FORMERLY REFERRED TO AS MEAN SEA LEVEL (M.S.L.) DATUM, BUT NOT TO BE CONFUSED WITH LOCAL MEAN SEA LEVEL.
1" = 4 Miles
NEW ENGLAND COASTLINE
TIDAL FLOOD SURVEY
TIDAL FLOOD PROFILE NO. 12
GEORGETOWN, MAINE TO
WINTER HARBOR, MAINE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS
JANUARY 1980

PLATE 3-2

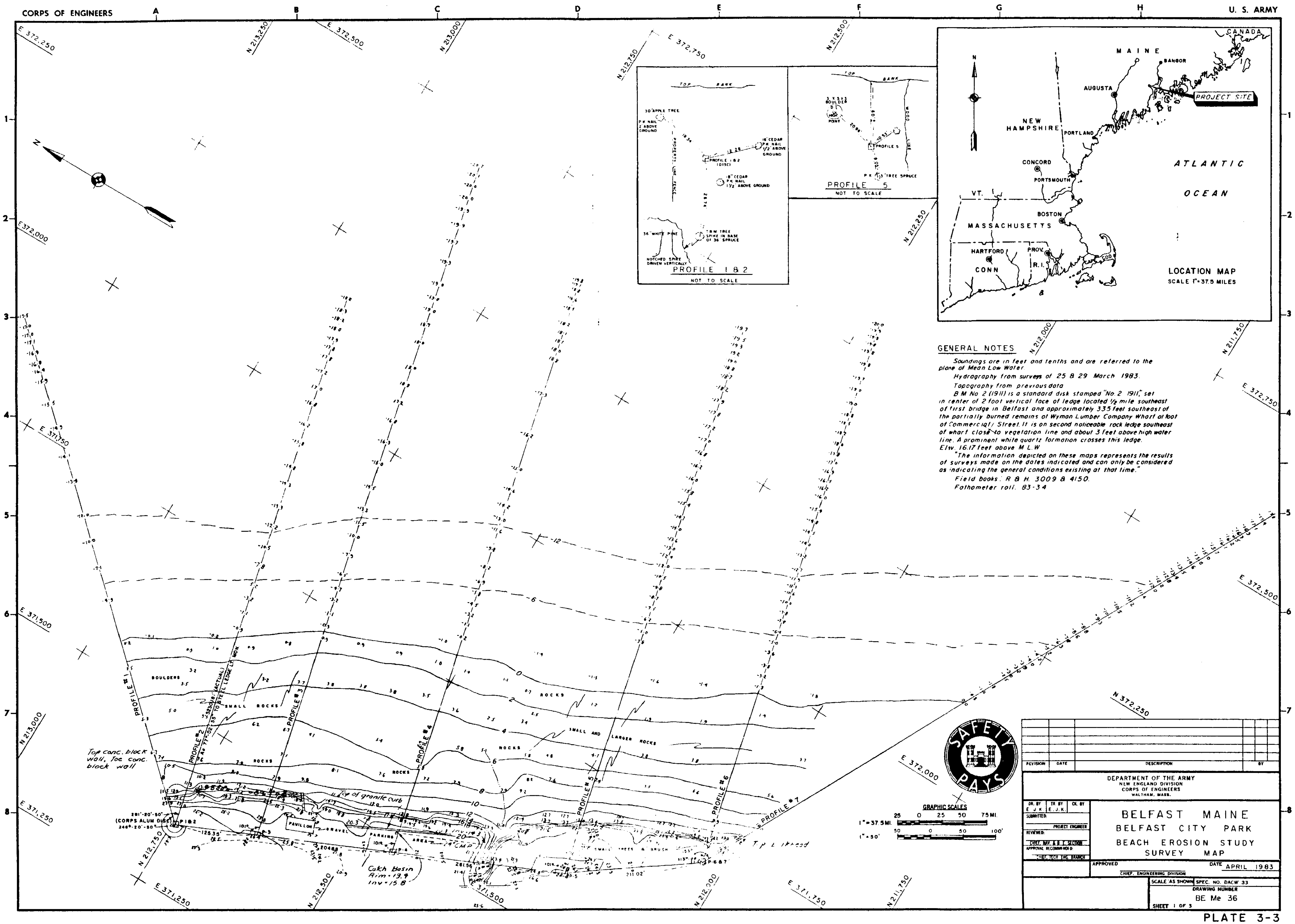
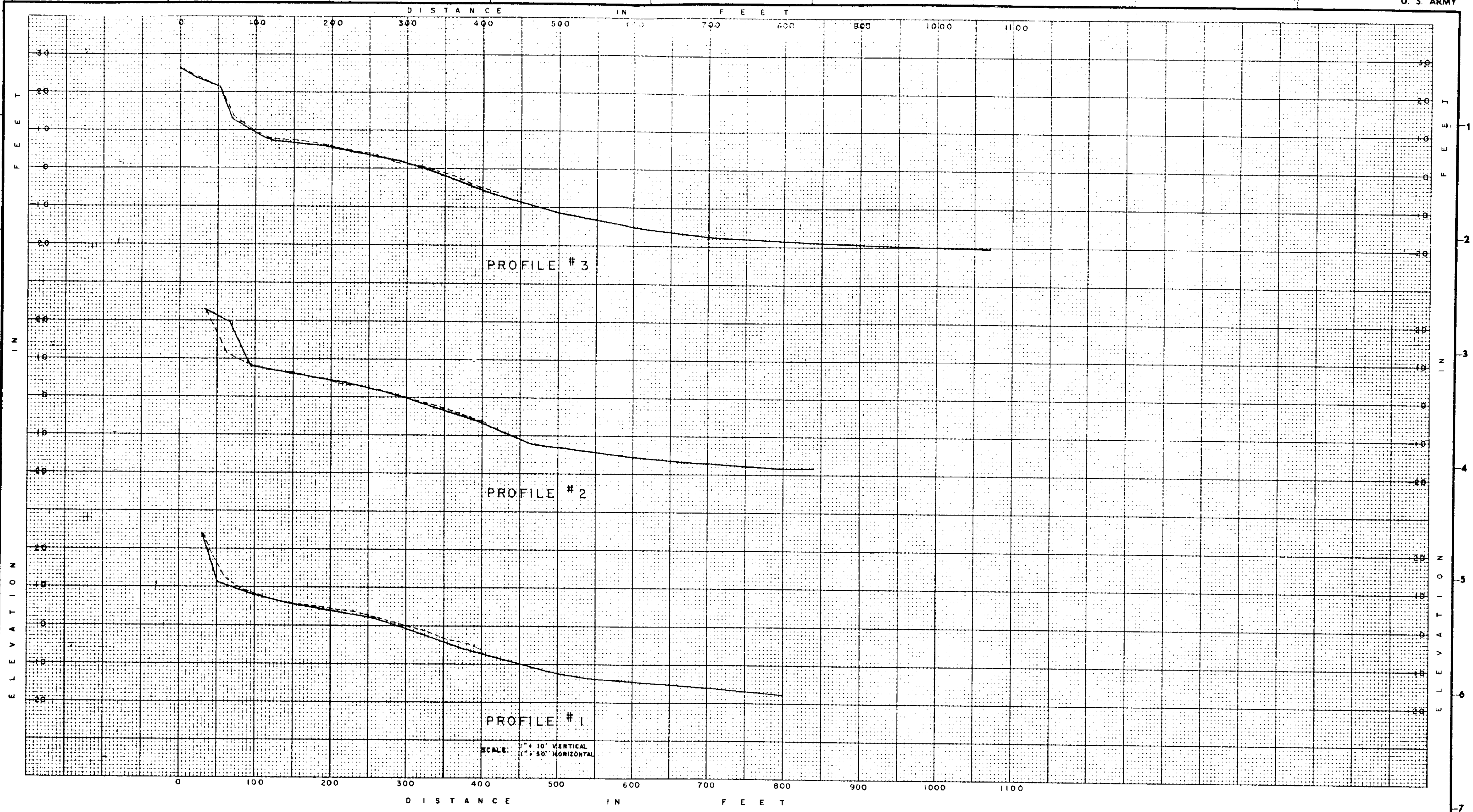
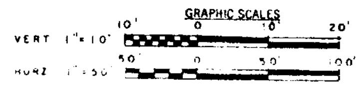

CORPS OF ENGINEERS
U. S. ARMY
PROFILE 1 & 2
NOT TO SCALE
PROFILE 5
NOT TO SCALE
MAINE
CANADA
BANGOR
AUGUSTA
PROJECT SITE
NEW HAMPSHIRE
PORTLAND
CONCORD
PORTSMOUTH
VT.
MASSACHUSETTS
BOSTON
HARTFORD
PROV.
R.I.
CONN
ATLANTIC
OCEAN
LOCATION MAP
SCALE 1"=37.5 MILES
GENERAL NOTES
Soundings are in feet and tenths and are referred to the plane of Mean Low Water.
Hydrography from surveys of 25 & 29 March 1983.
Topography from previous data
B M No 2 (1911) is a standard disk stamped "No. 2 1911," set in center of 2 foot vertical face of ledge located ½ mile southeast of first bridge in Belfast and approximately 335 feet southeast of the partially burned remains of Wyman Lumber Company Wharf at foot of Commercial Street. It is on second noticeable rock ledge southeast of wharf close to vegetation line and about 3 feet above high water line. A prominent white quartz formation crosses this ledge.
Elev. 16.17 feet above M L W
"The information depicted on these maps represents the results of surveys made on the dates indicated and can only be considered as indicating the general conditions existing at that time."
Field books: R & H. 3009 & 4150.
Fathometer roll. 83-34
PROFILE #1
PROFILE #2
PROFILE #3
PROFILE #4
PROFILE #5
PROFILE #6
PROFILE #7
BOULDERS
SMALL ROCKS
ROCKS
SMALL AND LARGER ROCKS
PAVILION
GRAVEL
PARKING AREA
Top conc. block wall, Toe conc. block wall
Top of granite curb
Catch Basin Rim = 19.9 Inv = 15.8
SAFETY PAYS
GRAPHIC SCALES
1" = 37.5 MI.
1" = 50'
REVISION
DATE
DESCRIPTION
BY
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
DR. BY E. J. K.
TR. BY E. J. K.
CK. BY
SUBMITTED:
PROJECT ENGINEER
REVIEWED:
CHIEF, NAV. & R. I. SECTION
APPROVAL RECOMMENDED:
CHIEF, TECH. ENG. BRANCH
BELFAST MAINE
BELFAST CITY PARK
BEACH EROSION STUDY
SURVEY MAP
APPROVED
CHIEF, ENGINEERING DIVISION
DATE APRIL 1983
SCALE: AS SHOWN
SPEC. NO. DACW 33
DRAWING NUMBER
BE Me 36
SHEET 1 OF 3

PLATE 3-3

CORPS OF ENGINEERS

U. S. ARMY





REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES BY E J K | DR BY E J K. | CK BY

SUBMITTED: PROJECT MANAGER

REVIEWED: CHIEF COAST ENG/SUR SECT

APPROVAL RECOMMENDED: CH DESIGN BRANCH

BELFAST MAINE
BELFAST CITY PARK
BEACH EROSION STUDY
PROFILES

APPROVED: CHIEF, ENGINEERING DIVISION

DATE APRIL 1984

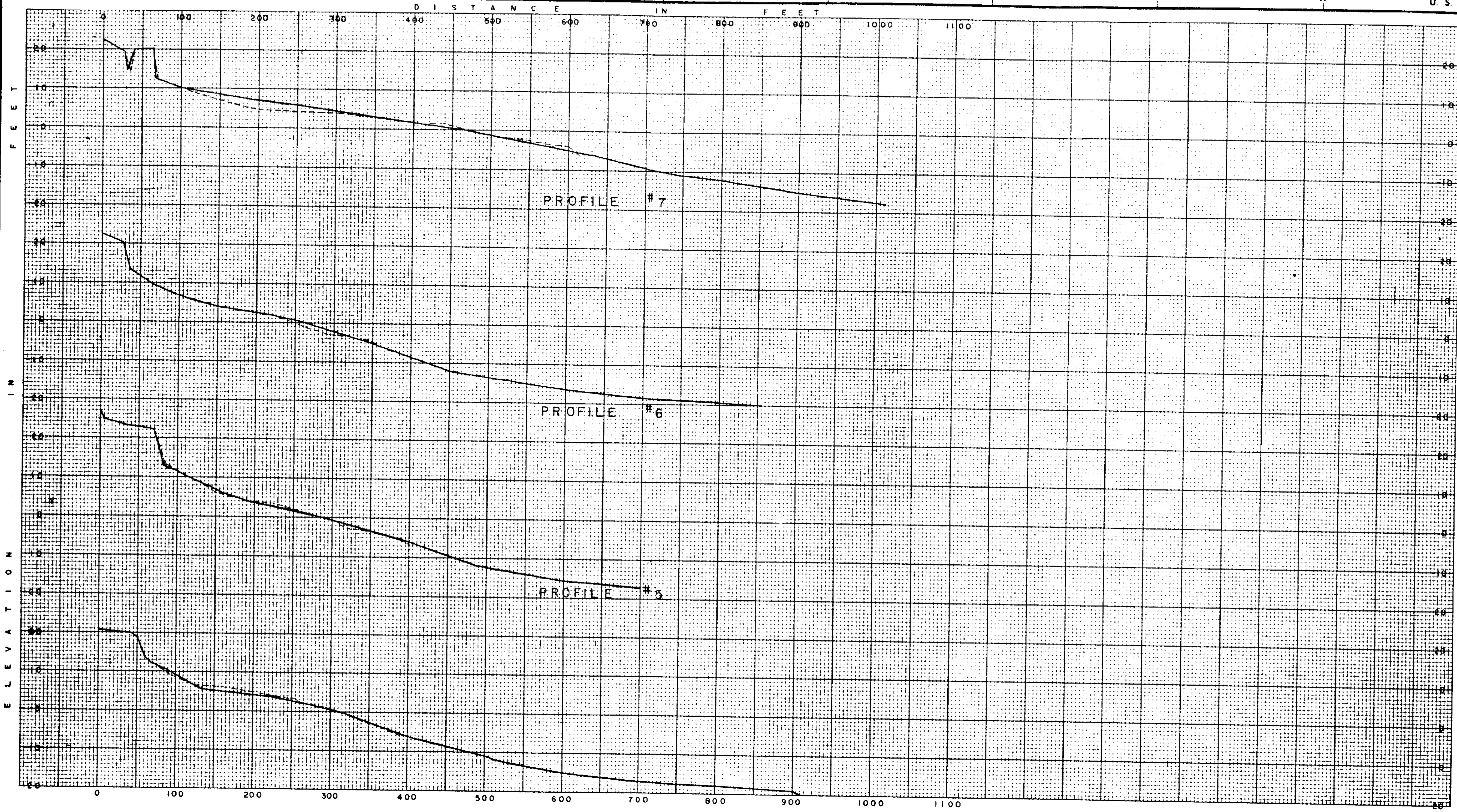
SCALE AS SHOWN | SPEC. NO. DACW 33

DRAWING NUMBER BE Me 36

SHEET 2 OF 3

PLATE 3-4

CORPS OF ENGINEERS U. S. ARMY



DISTANCE IN FEET

PROFILE #4

SCALE: 1" = 10' VERTICAL
1" = 50' HORIZONTAL

GRAPHIC SCALES
VERT. 1" = 10' 10' 0 10' 20'
HORZ. 1" = 50' 50' 0 50' 100'

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY E. J. K. | DR. BY E. J. K. | CK. BY

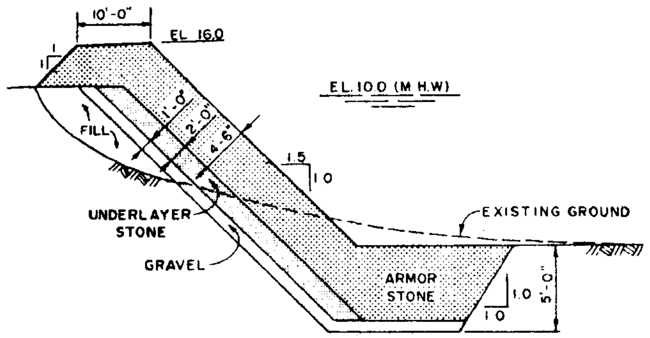
SUBMITTED: PROJECT MANAGER
REVIEWED: CHIEF, COAST. ENG/SUR. SECT.
APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH

BELFAST MAINE
BELFAST CITY PARK
BEACH EROSION STUDY
PROFILES

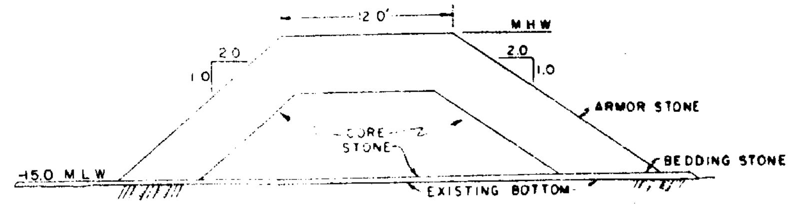
APPROVED CHIEF, ENGINEERING DIVISION DATE APRIL 1983

SCALE: AS SHOWN | SPEC. NO. DACW 33
DRAWING NUMBER BE Me 36
SHEET 3 OF 3

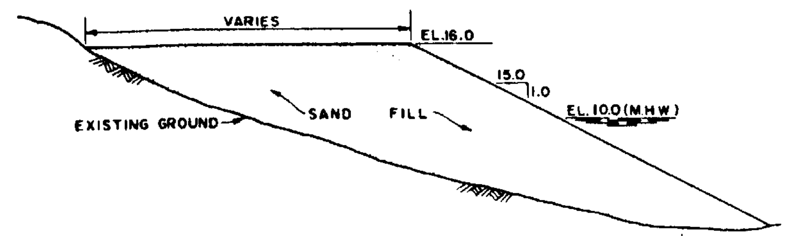
PLATE 3-5



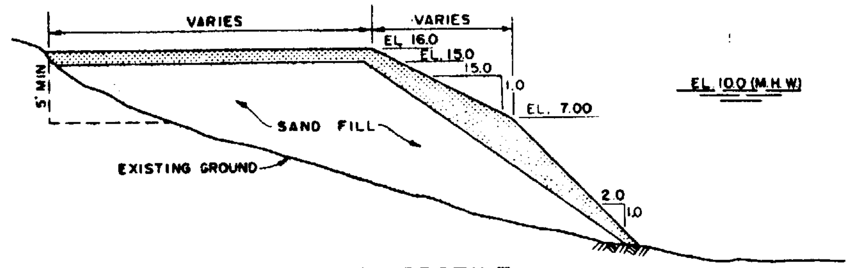
TYPICAL SECTION
ROCK REVETMENT
NOT TO SCALE



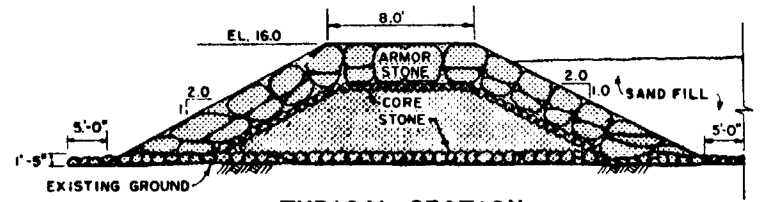
TYPICAL SECTION
OFFSHORE STONE BREAKWATER
NOT TO SCALE



TYPICAL PROFILE
SAND FILL
NOT TO SCALE



TYPICAL PROFILE
TERMINAL GROIN
NOT TO SCALE



TYPICAL SECTION
TERMINAL GROIN
NOT TO SCALE

NOTES:

1. ELEVATIONS ARE IN FEET AND TENTHS AND ARE REFERRED TO THE PLANE OF MEAN LOW WATER.
2. SANDFILL IN PLANS 1-4 INCLUDES CONSIDERED LEVEL BEACH BERM WIDTHS OF 50, 75 AND 100 FEET, A BEACH LENGTH OF 550 FEET, AND HAVE A BACKSHORE ELEVATION OF 15.0 FEET ABOVE MEAN LOW WATER. (10.4 FEET NGVD). THERE WILL ALSO BE 20 FEET OF ROCK REVETMENT NORTH OF THE NORTHERN GROIN STRUCTURE AND 20 FEET SOUTH OF THE SOUTHERN GROIN STRUCTURE FOR PLANS 2, 3 AND 4.

PLAN 1 - SANDFILL ONLY.

PLAN 2 - SANDFILL AND CONSTRUCTION OF TWO TERMINAL GROIN STRUCTURES AT THE NORTHERN AND SOUTHERN LIMITS OF THE BEACH.

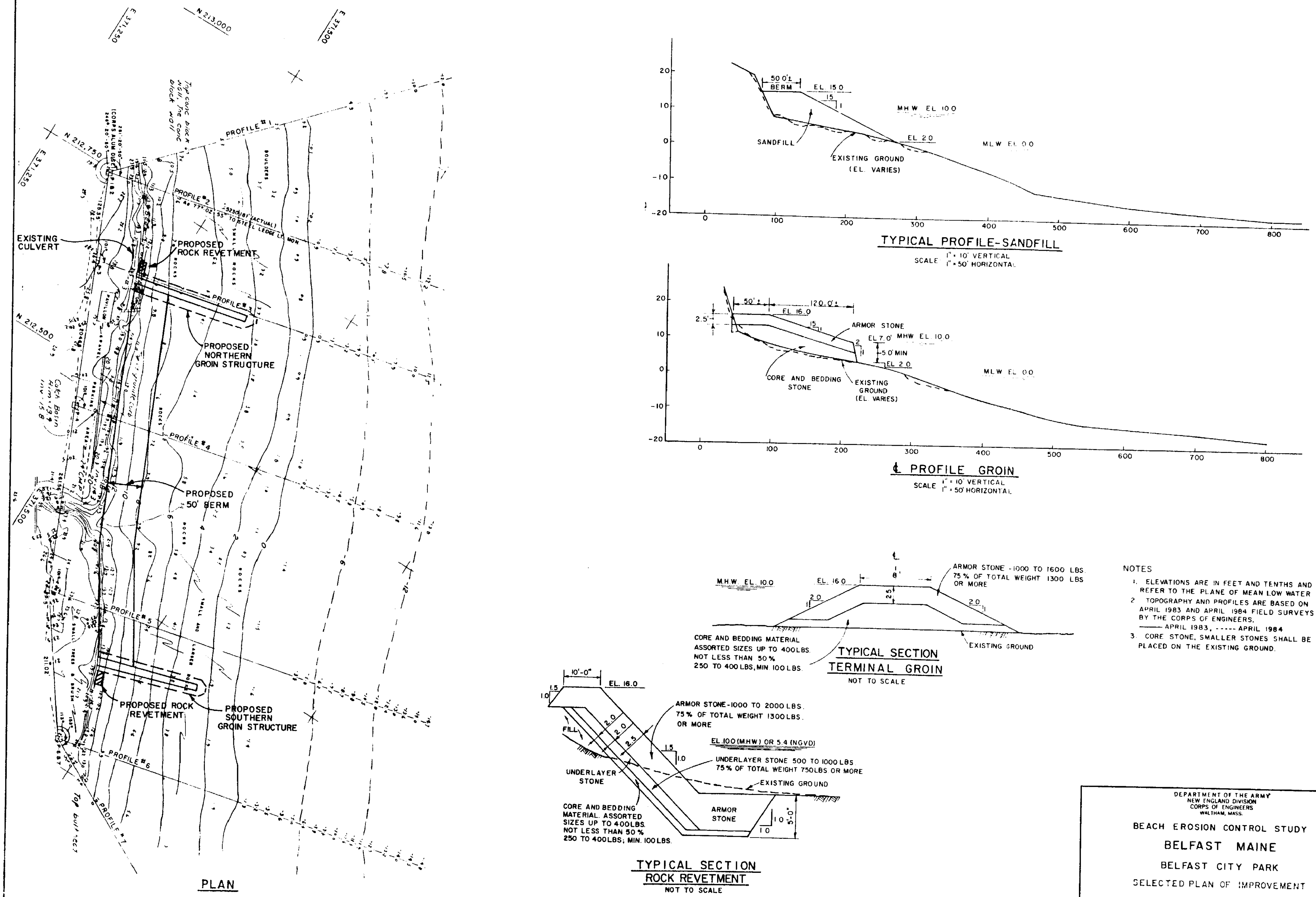
PLAN 3 - SANDFILL AND CONSTRUCTION OF A TERMINAL GROIN STRUCTURE AT THE NORTHERN LIMIT OF THE BEACH.

PLAN 4 - SANDFILL AND CONSTRUCTION OF A TERMINAL GROIN STRUCTURE AT THE SOUTHERN LIMIT OF THE BEACH.

PLAN 5 - ROCK REVETMENT ALONG THE 780 FOOT BACKSHORE AREA.

PLAN 6 - CONSTRUCTION OF AN OFFSHORE BREAKWATER APPROXIMATELY 1000 FEET IN FRONT OF THE 780 FOOT STUDY AREA.

BEACH EROSION CONTROL STUDY
BELFAST CITY PARK BEACH
BELFAST, MAINE
PLANS OF
CONSIDERED IMPROVEMENT
NOT TO SCALE
NEW ENGLAND DIVISION, CORPS OF ENGINEERS



NOTES

1. ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO THE PLANE OF MEAN LOW WATER
2. TOPOGRAPHY AND PROFILES ARE BASED ON APRIL 1983 AND APRIL 1984 FIELD SURVEYS BY THE CORPS OF ENGINEERS.
   ——— APRIL 1983, - - - - - APRIL 1984
3. CORE STONE, SMALLER STONES SHALL BE PLACED ON THE EXISTING GROUND.

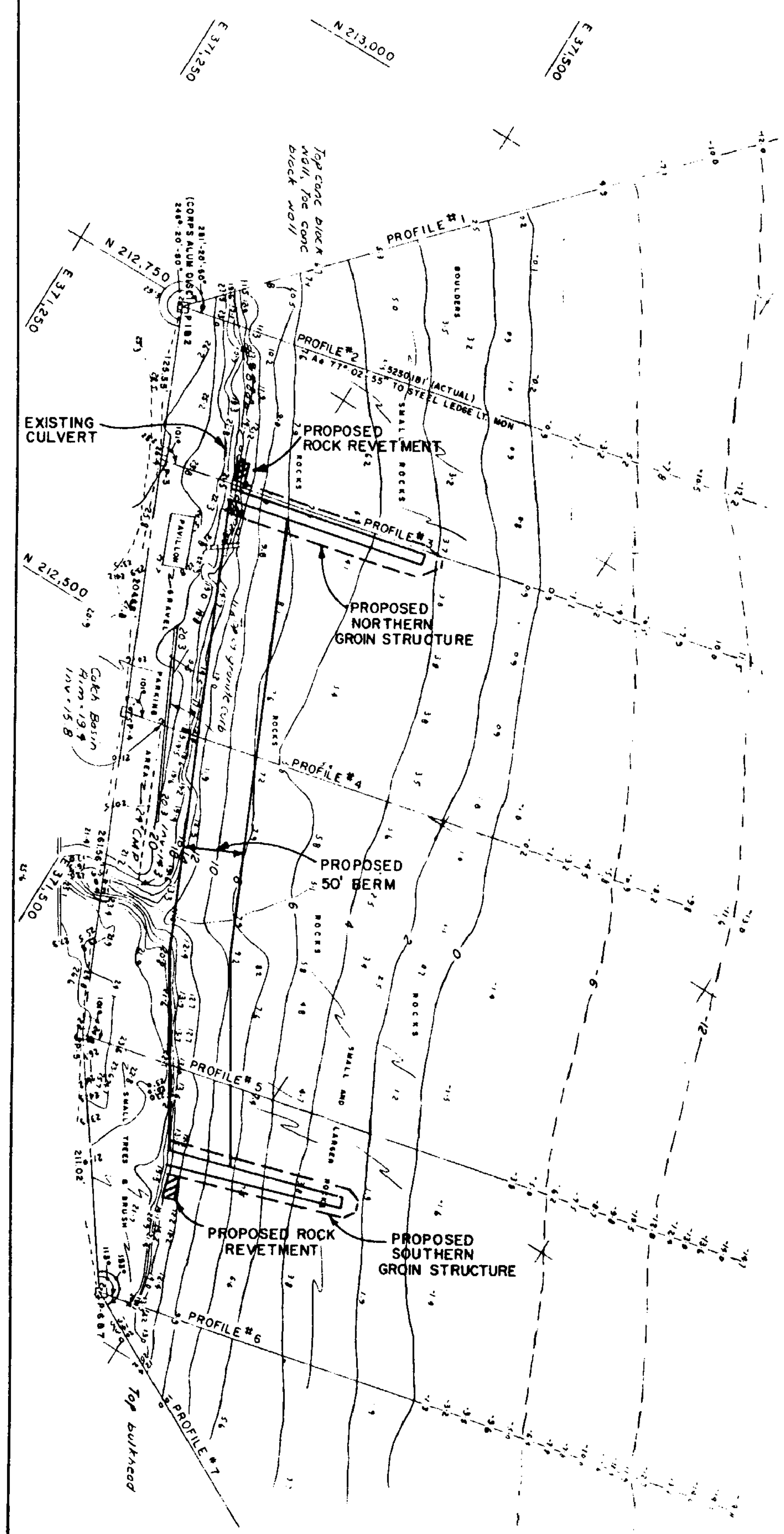
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

BEACH EROSION CONTROL STUDY

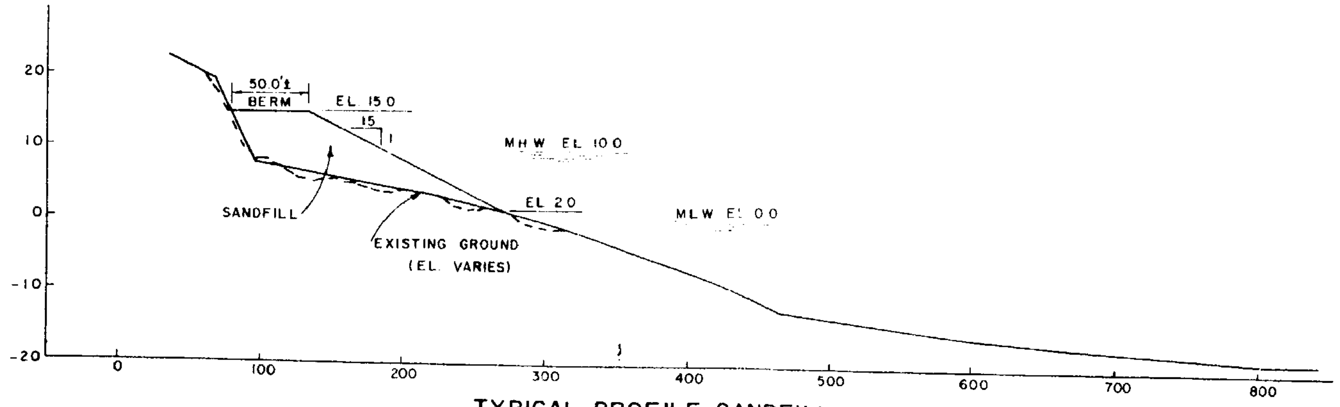
BELFAST MAINE

BELFAST CITY PARK

SELECTED PLAN OF IMPROVEMENT

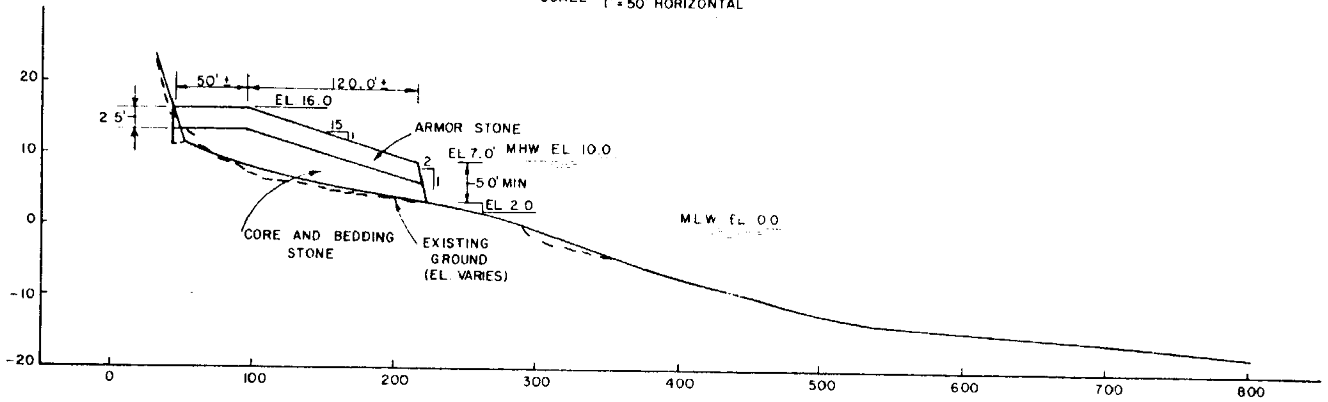


PLAN



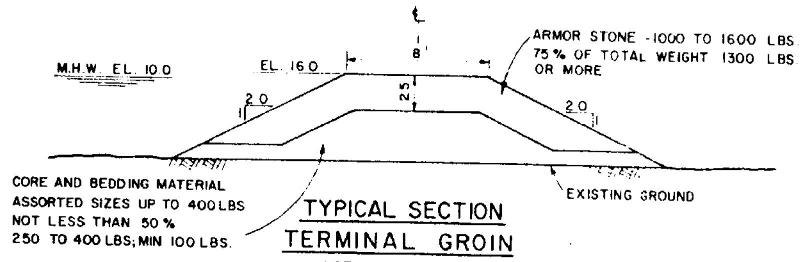
TYPICAL PROFILE-SANDFILL

SCALE 1" = 10' VERTICAL
1" = 50' HORIZONTAL

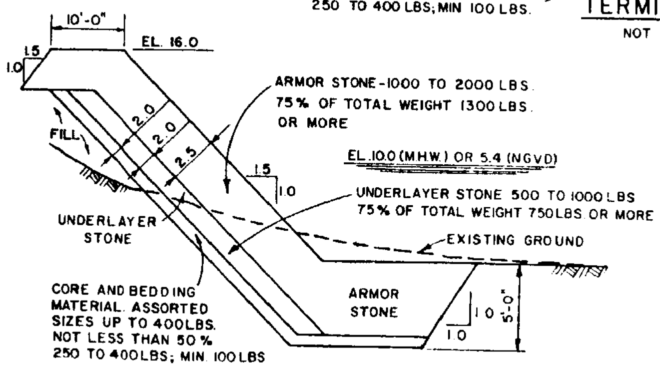


℄ PROFILE GROIN

SCALE 1" = 10' VERTICAL
1" = 50' HORIZONTAL



TYPICAL SECTION
TERMINAL GROIN
NOT TO SCALE



TYPICAL SECTION
ROCK REVETMENT
NOT TO SCALE

NOTES

1. ELEVATIONS ARE IN FEET AND TENTHS AND REFER TO THE PLANE OF MEAN LOW WATER
2. TOPOGRAPHY AND PROFILES ARE BASED ON APRIL 1983 AND APRIL 1984 FIELD SURVEYS BY THE CORPS OF ENGINEERS.
——— APRIL 1983, - - - - - APRIL 1984
3. CORE STONE, SMALLER STONES SHALL BE PLACED ON THE EXISTING GROUND

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

BEACH EROSION CONTROL STUDY

BELFAST MAINE

BELFAST CITY PARK

SELECTED PLAN OF IMPROVEMENT

PLATE 3-7